The Flora of New Zealand

W. MARTIN

Completely revised edition

THE FLORA OF NEW ZEALAND

W. MARTIN

Since the publication of the third edition of this book many changes have taken place in the classification and nomenclature of our native plants. This applies more particularly to the seaweeds, the lichens, the mosses and liverworts, the ferns and many genera of the flowering plants. Consequently, extension and major revisions of the text were called for in the preparation of the fourth edition, which, with the inclusion of many excellent new photographs, is now presented in an attractive modern setting. The use of popular and Maori names of plants as well as the scientific Latin terms gives added interest.

The Flora of New Zealand remains the only handbook covering all sections of the indigenous plant life of these islands, and has long been regarded as the standard work in this field. Teachers and students, as well as the host of amateur naturalists who desire a reliable, accurate and comprehensive guide to the study and identification of native species, will welcome the reappearance of Mr Martin's admirable work.

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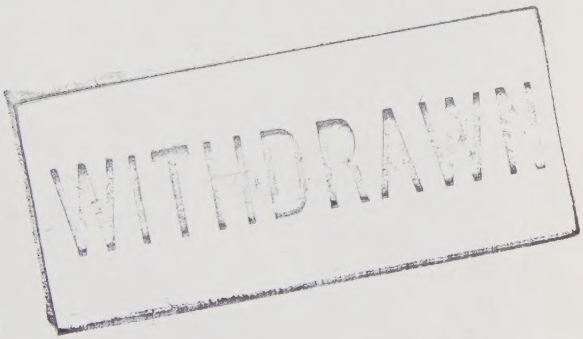
THE FLORA OF NEW ZEALAND



J. S. Thomson, photo

New Zealand plants growing in the garden of the late J. Scott Thomson at Dunedin

The Flora of New Zealand

W. MARTIN, B.SC.

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PREFACE

SINCE THE PUBLICATION of the previous edition of this handbook, many of the plant groups have been subjected to critical study and revision. This applies to the algae, the fungi and lichens, the mosses and the liverworts, the ferns, the rushes and sedges, the orchids, and other sections of the plant life of New Zealand, necessitating numerous changes in plant names. The author has incorporated these resultant modifications in the present volume wherever applicable, and has provided better illustrations.

The small size of the book and the wide scope of its contents render it impossible to supply much information about any individual plant; but it is hoped that teachers, trampers, students, and all plant lovers will find it useful, as it remains the only book available in popular form giving information about the seaweeds, fungi, lichens, hepatics, and mosses.

The author is greatly indebted to Mr. T. Thomson for his ready permission to make use of some of his father's excellent plant photographs as illustrations, and likewise to Professor Arnold Wall for his unsurpassed photograph of the penwiper plant.

W. MARTIN

INTRODUCTORY

New Zealand has so long been isolated from other land masses that it has developed a vegetation quite unlike that of any other country, notwithstanding the fact that there are many species which are also indigenous to Australia, South America, and elsewhere. In addition to uncounted microscopic organisms, the flora probably contains not fewer than five thousand species inclusive of all groups from algae to flowering plants, and of these at least two thousand five hundred are not to be found elsewhere. A flora so distinct as this is surely not only a unique possession, but a priceless heritage and a sacred trust which it is the duty of every New Zealander to protect, preserve and cherish.

Not the least interesting feature of the land flora is its dual character; for, at an elevation of approximately two thousand to two thousand five hundred feet there is a transition from a lowland subtropical vegetation to one that is as distinctly subantarctic in character. Yet, strangely enough, the natural flower gardens of New Zealand belong to the latter rather than to the lowland flora.

The distinctive character of the flora is shared by all classes of the plant life—the seaweeds and the mosses, the liverworts and lichens, the ferns and club-mosses, the fungi and the flowering plants. Indeed, the endemic element varies from one in every three in the mosses to four in every five of the flowering plants.

As this is the first and only book which introduces to the non-specialist reader the native seaweeds, mosses, fungi, liverworts, and lichens of New Zealand, it may be well to remind readers that each of these groups

possesses many unique and interesting features. Indeed, many botanists of international repute have drawn attention to the fact that each of these groups, as well as the ferns and lycopods, contains the largest and the finest representatives in the whole world. Together they far exceed in numbers of species, and probably of individuals also, the whole of the flowering plants.

It is difficult to give precise numbers to the species in any group, for additions still continue to be made as previously unbotanized areas are examined. Furthermore, some plants, once regarded as good species, are now known to belong to hybrid groups, of which vast numbers exist in the New Zealand flora, while opinions sometimes differ as to whether a particular plant should be classed as a valid species or as a variety of some other species. In round figures, the following may be accepted as indicating the position as known at present:

Flowering plants, 2,000; Ferns and their allies, 150; Mosses and Liverworts, 900; Fungi, 500 (omitting microscopic species); Lichens, 600; Marine Algae, 600.

With the exception of the tussock grasslands of Otago, Canterbury and the Volcanic Plateau, most of New Zealand, at the commencement of European settlement, was clothed in a dense, primeval rain-forest up to elevations varying from three to five thousand feet. The lowland forests were subtropical in character and comprised a community of taxads, thick-leaved, evergreen trees and tall tree-ferns, richly clothed in a mantle of epiphytic lilies, orchids, ferns, mosses, liverworts, and lichens, besides supporting numerous climbing plants and lianes.

Upland forests were mainly of antarctic type with one or other of two species of southern beech (*Nothofagus cliffortioides* and *N. menziesii*) as the dominant or sole tall trees. The associated species of flowering

plants were comparatively few in number, but mosses and lichens were usually conspicuous and abundant.

From the narrow shrub zone that usually separates the forests from the mountain herb-fields, fell-fields, and talus slopes, are derived a majority of those ornamental shrubs—*Olearias, Senecios, Hebes, Coprosmas, Dracophyllums,* etc.—which are being increasingly grown in public and private gardens. Amongst these shrubs and on the rocky or grassy slopes above, are to be found the choicest floral gems of the flora.

This is the natural home of countless acres of mountain daisies (*Celmisia*), some of the highest decorative merit; of giant buttercups unsurpassed elsewhere in size or beauty; of the charming snow marguerite (*Senecio scorzoneroides*) often growing in such profusion as to whiten the landscape; of unrivalled eyebrights (*Euphrasia*), ourisias, and forget-me-nots (*Myosotis*); of the two striking species of edelweiss (*Leontopodium*); of beautiful mats of the mountain everlasting (*Helichrysum bellidioides*); and of many striking species of bayonet grass (*Aciphylla*), one of which (*A. Scott-Thomsoni*) not infrequently throws up a massive flower-stalk ten or more feet high.

Vast debris-slopes and shingle-screes, which present conditions of soil and climate inimical to the existence of plant life, are populated nevertheless by a very specialized flora of about thirty-five species of which twenty-five fail to thrive elsewhere. Unstable areas such as these, subject to fierce gales, scorching sunshine, and temperature fluctuations from over 130° Fah. to far below freezing point, are the inhospitable home of such unique plants as the stick-plant, the penwiper, and the vegetable sheep (*Haastia*). All have thick, fleshy or leathery leaves, of a greyish hue similar to that of the surrounding rock debris. Stable alpine rocks are the even more

inhospitable home of the far-famed vegetable sheep (*Haastia* and *Raoulia*) and the remarkable coral shrub (*Helichrysum coralloides*).

A remarkable feature of the New Zealand flora is the existence of some 200 flowering plants which as juveniles are quite different from their adult form. In the majority this juvenile stage persists for many years. Again, of fifty shrubs having tough, wiry, interlacing branches and small leaves and outwardly closely resembling one another, neighbouring plants are often found to belong to genera or even families poles apart in relationship.

That the flora is unique is also proved by the fact that four out of every five native flowering plants are found nowhere else. To this endemic element belong no fewer than forty-two genera, many of which bear no close relationship to any other known plant. Such, for instance are the white-berried mistletoe (*Tupeia*); the root parasite (*Dactylanthus*) responsible for the 'wood roses' often sold as curios; *Myosotidium,* prince of forget-me-nots but better known as the Chatham Island lily; the marble-leafed putaweta (*Carpodetus*) and the showy *Ixerba,* both, however, members of the *Saxifrage* family. A remarkable fact pertaining to these endemic genera is that half of them are represented by a single species.

Among the more noticeable features of the plant life of this Dominion, the following are worthy of mention:

The tropical aspect of the lowland forests due to the abundance of lianes and perching plants; the wealth of ferns and the abundance of tree-ferns, and in places, of nikau palms; the large number of trees and shrubs with unisexual flowers; the comparative rarity of deciduous trees and of annuals; the sombre colour of the forest exterior, and the paucity of forest trees with showy blossoms; the predominance inside the forest of

cryptogamic plants, often to the almost complete exclusion of seedlings of flowering plants; and the presence of daisies and speedwells that reach the dimensions of trees.

Other features worthy of note are the rarity of blue or red flowers, and the abundance of yellow and white in the subalpine flower gardens and rockeries; the presence of those remarkable daisy shrubs known as vegetable sheep; and of 25 very specialized plants restricted to the inhospitable shingle screes. Wild hybrids are very numerous, over 600 such groups being recognised, including some previously regarded as valid species.

CHAPTER I

THE SEAWEEDS

ALL SEAWEEDS ARE ALGAE but not all algae are seaweeds. There are myriads of algae consisting of but a single cell, and many others of simple organization that abound in rivers, lagoons, and ditches. Such single-celled, microscopic algae are found on rocks, in lichens and orchids, on tree trunks, in the soil, and even in the air. The vivid red, especially of subalpine rocks, and the canary yellow patches on forest trees are algae as truly as are the plants known to everyone as seaweeds. In this chapter we shall be considering only such as inhabit the sea, and ignoring 950 freshwater species.

Every suitable station along the New Zealand coastline, from the spray-drenched cliffs above high-water mark to a depth of many fathoms, supports its quota of nearly six hundred species constituting the seaweed flora of this country. This great variety is in some measure a reflex of the wide latitudinal range of the coastline and the great diversity of suitable habitats; but no less is it due to a complex of environmental factors chief of which are the intensity and the quality of the light, the temperature and the salinity of the water, the duration of daily exposure to the air, and the degree of shade and shelter present.

Two in every five indigenous seaweeds are restricted to New Zealand, while a quarter are shared with Australia. Many have a circumpolar distribution and others range north to Polynesia. The number, however, that may be found from Auckland to Stewart Island is com-

paratively small; also few even of these are so large or abundant as to affect the physiognomy of the various zones or habitats.

In all parts of the world, the seaweeds belong to three important groups distinguished by their modes of reproduction as well as by their colours. They are known as the greens, the browns, and the reds; but it must always be kept in mind that brown seaweeds, especially when dried, may appear to be black, and red algae may appear brown, purple, pink or black unless examined by holding them between one's eye and the sun.

Speaking generally the greens may be classed as shallow water algae, the reds as deep water plants, and the browns as plants of the intermediate zone. To this rule there are, however, not a few exceptions, for some reds may be found on rocks near high-tide levels or greens in the deep off-shore waters.

Seaweeds differ from flowering plants in many ways. None have true roots or water-conducting stems. Few have leaves and none have flowers, fruit or seed. Many have root-like haptera to fix the plant to the substratum; but as the plants are surrounded by water for at least part of every day they absorb their nourishment through every part of the frond. Propagation may be by spores or by fertilized egg-cells or by purely vegetative means. Many seaweeds grow attached to other seaweeds as epiphytes or more rarely as parasites. These last have no chlorophyll to manufacture their own carbohydrates and depend wholly on the host plant to supply these.

Buoyancy is secured by many of the largest seaweeds by the presence of numerous air-filled floats or as in Bull-kelp, by large air-filled cells. Seaweeds that are daily exposed to the air take steps to reduce the rate of desiccation by the presence of mucilage on the

surface, swollen stems containing water, or a thick leathery cortex on the fronds.

Though quite a number of seaweeds are widely distributed, others are comparatively local. Many are restricted either to the North Island or to the South Island; the range of others includes not only North Island coasts but northern parts of the South Island; yet others are found in the South Island and half the North Island. Deep seas, the mouths of large rivers, and long stretches of sandy beach act as barriers to distribution as much as changes of salinity or temperature. Then, in any single locality, there is a zoning of the seaweeds on the intertidal belt both on exposed rocks and in tidal rock pools. Even below low-water there is a further zoning.

To give one example, we could expect to find the tubular grass-green species of *Enteromorpha* only in high-tide rock pools especially in such as may be diluted by seepage or by rain water. Similarly on the exposed rocks near high-tide levels, the MOSS-WEEDS (*Bostrychia*) will alone be found. Flattish rock surfaces near mid-tide levels are the usual station for such well-known seaweeds as the SEA BOMB, SEA CACTUS, VENUS' NECKLACE, or PURPLE LAVER. Mid-tide rock pools may be found encrusted with Coralline seaweeds and containing such plants as *Bryopsis plumosa* and various small epiphytic red algae. Sloping sides of rocks in this zone that are exposed for comparatively short intervals are the usual station for bushy tufts of *Scytothamnus*.

Rocks that are exposed only at low-water mark have their appropriate species also. On open coasts these form the usual station for BULL-KELPS, STRAP-WEEDS, and dull red leathery *Pachymenia*. In calmer waters, the NEW ZEALAND CARRAGEENS (*Gigartina*)

W. Martin, photo

FIG. 1.—Seaweeds of the intertidal belt, Stewart Island, here consisting mainly of Bull-kelp (*Durvillea*), Strap-weed (*Xiphophora*), Moss-weed (*Bostrychia*), Neptune's Necklace (*Hormosira*), and *Sea Bombs* (*Adenocystis*)

occupy a similar zone, as does the ROCK SPONGE or TUBEROUS VELVET WEED (*Codium adhaerens*). A little lower down where the seaweeds are permanently submerged we have such plants as the GRAPELET, the WIREWEED, and OX-TONGUE; the FLAP-JACK and GIRDLE WEEDS. In rather deeper water within their range of distribution we have the *Lessonia* and the OARWEED, the GRAPEWEEDS, and numerous representatives of the red algae. In really deep water there are scores of seaweeds usually of delicate texture and rich red or pink colour; but this is the location also of the common KELP that rides the incoming swell with its leafy surface branches while attached to the bottom by long rope-like stems and branching holdfasts.

Now, it must not be supposed that the above-named seaweeds are to be found on all parts of the coast, even when suitable stations are available, for many have a restricted area of distribution. Thus species of *Cladophora* are rare save on Otago coasts, while *Vidalia* will not be found save on Auckland coasts.

Propagation in seaweeds may be vegetative, by spores, or by fertilized egg-cells. Some of the red seaweeds have three distinct forms (e.g. *Gigartina*)—sterile, cystocarpic, and tetrasporic; and in consequence it is not always easy to identify a particular species with certainty. The individual plants of the brown seaweeds are usually either male or female, and new plants arise from fertilized cells.

Over a dozen genera have no representatives outside of New Zealand, and a score of others are restricted to Australia and New Zealand. Recent researches have added both new genera and many new species to the seaweed flora, but there still remain many unsolved problems and doubtless many undiscovered species, especially on the West Coast.

In recent years, an important industry has been inaugurated in this country for the manufacture of agar-agar from species of *Pterocladia* and *Gelidium*. This jelly-like substance is used by meat-canning firms as a filling for tinned meats, by hospitals for cultivating bacteria in the diagnosis of disease, and by the makers of sweets and cosmetics. A South Island firm is also engaged in preparing sea-meal for culinary purposes from several species of NEW ZEALAND CARRAGEEN (*Gigartina*). Owing to the high iodine content of seaweeds, races such as the Maori or Japanese who formerly included these in their dietary had a very low incidence of goitre. Bull-kelp fronds were formerly split to form suitable receptacles for consigning muttonbirds to distant parts of the country.

The Green Seaweeds

The green seaweeds of New Zealand shores numbering possibly sixty species, are mostly restricted to the intertidal belt and to a narrow zone below low-water level. A big percentage at high-tide levels belong to the two genera, *Enteromorpha,* tubular and grass-green, and *Cladophora* with filamentous fronds. The former are located in high-water tidal pools, and the latter on the sandy bottoms of pools and runnels, especially on Otago and other southern coasts. These last are the HAIR-GRASS seaweeds, so abundant in Otago Harbour as to form large mounds on the beaches after rough weather.

Of the green algae, however, none are more conspicuous than the various species of SEA LETTUCE (*Ulva*) which abound on rocks and even on muddy bottoms in sheltered waters. Where there is an escape of sewage, the fronds may form sheets of great size. A long ribbon-like West Coast weed that resembles

FIG. 2. Common Green Seaweeds and one Brown Seaweed

1. *Scytothamnus lomentarium* (brown); 2. *Caulerpa sedoides*; 3. *Codium fragile*; 4. *Chaetomorpha darwinii*; 5. *Caulerpa brownii*.

Ulva has recently been christened *Lobata phyllosa.* It has a distinct midrib margined by much-crisped membraneous wings. *Lobata* is also found near Dunedin.

Rock pools and rocks just below low-water are the favourite haunt of several species of *Caulerpa,* much the most widely distributed and commonest member being the RIMU-RIMU (*C. brownii*) though confined to areas south of Castle Point. North Island shores in similar stations have several other species of *Caulerpa,* the best known being the tall *C. hypnoides* and the GRAPELET (*C. sedoides*) which occurs in quantity at and north of Wellington but only on the east coast. The rimu-rimu, though widely distributed, is also absent from the West Coast of Wellington as well as from the coasts of Auckland. The grapelet can be recognised at a glance from the fact that each stem, two to six inches long, is surrounded by small globular green beads so as to resemble an elongated, if miniature, bunch of grapes.

The genus *Codium* is represented by six species, only two of which range south as far as Stewart Island. The first of these is the ROCK SPONGE already mentioned, which forms sometimes small, sub-globular, green, plushy cushions on rock surfaces just above or at low-water; but it also forms convoluted cushions of considerable extent. *C. fragile,* on the other hand, though no less common is a dark green seaweed with stems and branches about the thickness of a lead pencil. It may be attached to rocks, shells, or even sponges, and as a result is often cast up on beaches in stormy weather.

Intertidal rock pools of the North Island commonly harbour the small delicate green plumes of *Bryopsis plumosa,* a seaweed only an inch or two high with opposite branches and branchlets. In the same pool may be found an epiphytic green seaweed with stems resembling a string of beads, the largest at the top. The

largest of several forms is *Chaetomorpha darwinii* sometimes designated MERMAIDS' BEADS or SEA EMERALDS. This has stems up to six inches long and more. The other species have the same form and colour but are much smaller. *C. darwinii* becomes increasingly common as we travel south from East Cape.

The Brown Seaweeds

The brown seaweeds form a very natural group distinct from other algae not only in colour but in life history as well. Some, such as the common kelp and *Lessonia*, are olive-brown, others like the BULL-KELP are dark brown, and yet others, especially when dry, may appear almost black, as in the case of the OAKWEED, FLAP-JACK, or COMB-WRACK.

The members of this group are commonly of large size, and include the largest algae known. They grow as a rule from low-water mark to a depth of several fathoms as well as in surge channels, where they are invariably the dominant species on exposed coasts.

The only seaweeds provided with special air-filled floats belong to the brown algae, but only a fraction of these are so provided. The SEA BOMB and the SEA CACTUS are examples of annual seaweeds, while the zoning of such as occupy the intertidal belt depends on the ability of each to withstand desiccation between tides. To this end VENUS' NECKLACE has water-filled, swollen internodes; and the sea bomb is also filled with water for a like purpose. The existence of this water is known to most children, who call the plant the WATER SQUIRT. The sea cactus, on the other hand, is filled with a slimy fluid which keeps the frond perpetually moist; while the fronds of the bull-kelp (or PURPLE LAVER among the red algae) have a coating of mucilage giving protection alike from damage by wave action or by desiccation.

Of the several groups into which the brown seaweeds are grouped, the two principal are the Laminarians including the *Lessonia,* kelp, and oarweed; and the Fucoids to which belong all the largest of the remainder; and as these are the dominant groups on almost every part of the coastline they will be referred to more completely than in the case of either the greens or the reds.

The Laminarians

(1) **Kelp** or **Bladder-kelp** (*Macrocystis pyrifera*)

For what is claimed to be the world's longest seaweed some fabulous dimensions have been recorded; but it is certain that plants with stems exceeding one hundred feet have been measured by recognised authorities. Kelp is abundant in Stewart Island waters and along the east coast of the other islands as far north as Castlepoint, more especially in sheltered waters or just beyond the zone of the coastal breakers. From a massive much-branched holdfast the stems rise to the surface supported by the pear-shaped floats at the base of each ribbon-like leaf. The numerous leafy branches may cover the surface for extensive areas and become a real hindrance to launches and other surface craft. The spores, however, develop on submerged floatless leaves near the base of each stem. Being specially rich in potash, kelp is in demand in many places as a fertilizer for the vegetable garden. It is said to be the principal food of the butterfish.

(2) **Lessonia** (*L. variegata*)

The New Zealand *Lessonia* lacks the massive proportions of several South American species, rarely exceeding a yard in height. It occurs in isolated areas along the coasts of both islands and is nowhere more common than on exposed shores near Wellington, though it is

a perpetually submerged seaweed not much disturbed by wave action save in rough weather. The leaves are similar to those of the kelp save that they lack the basal float. New leaves result from the controlled splitting of existing leaves and are borne on numerous short stems attached to a much-buttressed holdfast, unlike that of any other New Zealand seaweed in appearance.

(3) **Oar-weed, Paddle-weed,** or **Octopus-weed** (*Ecklonia radiata*)

This is another Laminarian occupying similar stations to *Lessonia* but rarely in the same areas. It has a very distinctive form. From a small, branching holdfast there rises a short cylindrical stem suddenly expanded into a broad flat expansion like the blade of an oar. This is margined by similar wide expansions. It is a dark-coloured plant especially when dry and rarely much exceeds thirty inches in height. It ranges to Otago, but is uncommon save on North Island coasts and then only at isolated locations. One or two smaller species of *Ecklonia* are now known from northern waters. All are rich in iodine.

THE FUCOIDS

(1) **Bull-kelp** (*Durvillea antarctica* and *D. willana*)

The former of these two massive seaweeds ranges from the Three Kings north of New Zealand right to the Antarctic, becoming ever more plentiful and more vigorous as we go south. It grows only on storm-lashed coasts and at low-water mark or just above it. The second bull-kelp, which reaches its northern limit at Castlepoint, occurs on both the east and west coasts of the South Island as well as on the coastal rocks of Stewart Island.

D. antarctica grows on rocks that are exposed briefly only at low-tide. From its massive shield-shaped holdfast several stems as thick as one's wrist are given off that merge into the frond proper. These fronds take two distinct forms which, though occasionally associated, usually occupy exposed stations and surge channels respectively. The former fronds are wide, massive, and undivided, those of the other being divided into long, narrow thongs. The centre of each frond, whatever its form, is occupied by large honeycomb cells which impart great buoyancy, and the exterior coating of mucilage prevents damage by wave action and desiccation, for the fronds are at all times exposed to the air. Each plant is either male or female, the sex cells being liberated copiously into the mucilaginous coating especially in the winter months.

D. willana grows in rather deeper water where the holdfasts are only rarely exposed during spring tides. It is easily distinguished from the previous plant by the presence of massive branches originating along the main stems, by the absence of the large honeycomb cells, and by the less slippery fronds.

(2) **Bladder-weeds** (*Cystophora* and *Carpophyllum*)

All the numerous species of bladder-weeds possess air-filled floats which aid them to maintain an erect position without imposing extra strain on the holdfast. All are bushy seaweeds of surge channels or in water up to several fathoms deep. The species of *Cystophora* have, with one exception, markedly zig-zag, flat stems, the branches being attached to the flat surface and not to the edge as in the *Carpophyllums*. Each branch is bent downwards at the base before turning outwards. They range along the east coast and are much alike, but the commonest is probably *C. retroflexa*. All are

FIG. 3. Three Brown Seaweeds: 1. *Carpophyllum maschalocarpum*; 2. *Carpophyllum phyllanthus*; 3. *Cystophora torulosa*

found on Australian coasts also. *C. platylobium* differs from the other species in having the pinnae attached to the margins of the stems. *C. plumosum* forms submarine forests on some northern coasts.

The species of *Carpophyllum* are distinguished by their leafy habit and marginal insertion of the branches, while each float carries a sharp point at the apex. The commonest of four species is *C. maschalocarpum* which has been designated by the apt and appropriate name of FLAP-JACK from the habit of the plant in swaying first in one direction and then in the other as the water enters or recedes from the surge channels between tidal rocks. The name would not apply to the other species which prefer deeper water. Like this plant, *C. plumosum,* a North Island plant and the commonest in Rangitoto Channel in Auckland Harbour, is restricted to New Zealand coasts north of Castlepoint. *C. flexuosum* is a luxuriant, leafy seaweed preferring the deep pools and calmer waters of harbours and inlets, whereas the flap-jack is found only on the open coasts. Normally the bladder-weeds are plants two or three feet tall, but in ideal stations, heights of six and seven feet are common enough.

(3) The **Grape-weeds** (*Sargassum*)

Sargassum is a Spanish name for seaweed, and has given the name Sargasso Sea to an area where floating seaweed covers the surface for miles at a stretch. It is said to be Portuguese for 'small grapes' which would aptly apply to the several species of *Sargassum,* which all have numerous, small, spherical floats little larger than the berries of the currant. Much the commonest of six local grapeweeds is *S. sinclairii,* especially in northern waters. It ranges to Stewart Island, but is far from abundant in southern waters. The best marks

FIG. 4. Brown Seaweeds: 1. *Sargassum sinclairii*; 2. *Landsburgia quercifolia*

for its recognition are its slender, wiry stems, leafy habit, and numerous small floats each shortly stalked and frequently terminated by a leafy tip. In common with the other fucoids these are commonest in waters a few fathoms deep.

(4) **Comb-wracks** (*Marginariella*)

The two species of this endemic genus are alike in their possession of fronds bearing numerous floats and pod-like spore receptacles on one side only of each frond. In the SEA-SAW (*M. urvilleana*) each long, strap-shaped leaf is margined on its outer edge by sharp hooked teeth. The other comb-wrack (*M. boryana*) has long, ribbon-like fronds usually lacking the prominent sharp teeth of the other plant, and elliptical floats terminating in a sharp point, those of the sea-saw being globular and without the terminal projection. Both are plants of rather deep water from Cook Strait southwards, and both turn almost black on drying. Fronds of *M. boryana* may attain a length of four feet or more, the other being a shorter plant with broad leaves, occurring in less exposed stations.

(5) **Oakweed** or **Oak-leafed Sea-wrack** (*Landsburgia quercifolia*)

The OAK-WEED belongs to yet another endemic genus with two distinct species, one confined to the Chatham Islands and the other to the main islands, though only north of Banks Peninsula and in rather deep water. From a small disc-shaped holdfast several slender, wiry stems three or four feet long arise, bearing much-lobed leaves shaped like those of the English oak. It possesses no floats and, like the sea-saw, dries black.

(6) **Strap-weed** (*Xiphophora*)

The commonest and possibly the only species (*X. chondrophylla*), though another has been recorded, has at least two well-marked forms, that found in northern waters having much narrower fronds than southern plants. The strap-weed is a common associate of the bull-kelp and is exposed briefly at low tide. Each

W. Martin, del.

FIG. 5. Some common Seaweeds

1. Common Surf-weed (*Pachymenia lusoria*); 2. Mare's-tail (*Sphacelaria*); 3. Fan-weed (*Zonaria*); 4. Carrageen (*Gigartina*); 5. Rimu-rimu (*Caulerpa*); 6. Rock Girdle of Flap-jack; 7. Notched Sea-wrack (*Marginariella*); 8. Leaf of Common Kelp (*Macrocystis*); 9. Tangle-weed (*Cystophora*); 10. Green Hairweed (*Cladophora*); 11. Grapelets (*Caulerpa*); 12. *Sargassum* or Grapeweed; 13. *Lessonia;* 14. Ox-tongue (*Glossophora*); 15. Octopus-weed; 16. Sea Bombs (*Adenocystis*); 17. Sea Cactus (*Splachnidium*); 18. Gut-weed (*Enteromorpha*); 19. Bubble-weed; 20. Coralline seaweed; 21. Neptune's Necklace (*Hormosira*); 22. Sea Emeralds (*Chaetomorpha*); 23. *Cladhymenia*; 24. Sea Lettuce (*Ulva*).

frond consists of a broad strap which repeatedly forks, each branch having the same width as the basal portion. The leathery consistency gives it the necessary strength to resist damage by the breaking surf. It commonly grows as a continuous band encircling emergent rocks at low-water levels on exposed coasts.

(7) **Neptune's Necklace** or **Necklace Seaweed** (*Hormosira banksii*)

This is an abundant seaweed on flat-topped intertidal rocks and in rock pools and was the first seaweed to be reported from Australia and New Zealand. It was named after Sir Joseph Banks, its discoverer. Each stem and each branch resemble a string of beads, each bead being a swollen and hollow internode measuring about a quarter of an inch in width. Tons of this weed have had to be removed from the rock oyster beds in Auckland. At Picton a form of this plant has been reported as growing on mudflats without attachment of any kind to the substratum. A small but closely related fucoid frequently growing on it as a parasite is known as *Notheia anomala*. The beads retain water to resist desiccation during the long intervals of exposure to the air between successive tides.

Other Brown Seaweeds

(1) **Sea Cactus** or **Gummy-weed** (*Splachnidium rugosum*)

This annual seaweed grows on flat intertidal rocks in all but the months of winter. Each plant comprises a central erect, olive-green or brown cylindric frond with short saccate branches filled with mucilaginous sap. It commonly measures three to six inches tall, and up to half an inch in width.

(2) **Sea Bombs** or **Water Squirt** (*Adenocystis utricularis*)

Growing in the same stations as the last plant, there may be found from October to May colonies of a small pear-shaped seaweed two or three inches long, on any suitable site south of Cape Turnagain. These hollow,

saccate, bomb-shaped and unbranched seaweeds may be hollow or filled with water, in which case children love to use them as water-squirts. Like the gummy-weed this is a strictly annual seaweed.

(3) **Brown Sea-moss** (*Scytothamnus australis*)

This seaweed grows in the same zone as the two previous plants but on the sloping sides of emergent rocks rather than on flat rock platforms for which the

W. Martin, photo

FIG. 6. Neptune's Necklace (*Hormosira*) on mid-tide rocks

others show a distinct preference. Each plant forms a bushy tuft, dark brown in colour, yet of quite unattractive appearance. Though it is normally only a few inches long, robust specimens may measure a foot or even more. The ultimate branches though slender are moderately rigid. It is abundant on all circumpolar shores.

(4) **Sea Sausage** (*Scytosiphon lomentaria*)

The SEA SAUSAGE grows in shallow rock pools, on low-tide rock platforms, on tidal flats, or in tidal runnels. Its long, hollow, cylindrical fronds are unbranched and constricted at intervals. They vary in thickness from that of a quill to that of one's little finger and resemble closely a string of sausages in a butcher's shop. These air-filled internodes enable the plant to maintain an upright habit, but some plants are much less constricted than others. It disappears in the summer months.

(5) **Fan-weeds** (*Zonaria*)

Two species of *Zonaria* grow in rock pools and surge channels, one (*Z. velutina*) dwarf and frequently embedded in sand, the other (*Z. subarticulata*) much taller and more copiously branched. The tips of each frond are often expanded to form a sort of fan marked with concentric additions of growth which give them a banded or zoned appearance from which circumstance the botanical name was suggested. These fans are much more pronounced on the smaller species than on the other weed.

(6) **Ox-tongue** (*Glossophora kunthii*)

The fronds of this dichotomously branched seaweed are covered with rough outgrowths bearing the organs of reproduction, which resemble the surface of a cow's tongue. It is quite a common seaweed of surge channels and water one or two fathoms deep. The dark colour and rough surface make identification easy. Large plants may exceed a foot in length.

THE RED SEAWEEDS

Though all seaweeds of this group contain a red pigment, it does not follow that externally all are red

in appearance. On the contrary, few forms on the emergent tidal rocks are noticeably red till viewed by transmitted light. Rather do they appear russet, purple, purplish brown, or even green or black; but deep water forms frequently display not only great beauty and delicacy of form but likewise of colour which may range

FIG. 7. Red Seaweeds

1 and 1a. *Phyllophora lacera*; 2. *Gigartina* [illegible]; 3. *Gigartina marginiflexa* (?); 4. *Gigartina clavifera*

from rose pink to deep scarlet or crimson lake. Normally, plants of deep water are undisturbed by surface waves; but in stormy weather they may be detached from their substratum; or, together with the host seaweed on which so many grow, they are cast up on the beaches as driftweed. It is then, only when floated in water, that their real beauty becomes vividly apparent in the case of the more filamentous or membraneous species.

New Zealand waters have a population of almost four hundred of these red marine algae, a majority being rather small epiphytes such as the numerous species of *Polysiphonia* or *Ceramium,* or even parasites. Lime-coated Coralline seaweeds are represented by some thirty species, some encrusting the rock surfaces and others forming bushy plants with jointed stems.

The life histories of most red seaweeds are known to be somewhat complex. An asexual plant produces tetraspores giving rise to male and female plants which, in turn, after fertilization, develop carpospores that give rise once more to the asexual plants. Each stage in some cases has a distinct form, so that it sometimes (e.g. in *Gigartina*) becomes a difficult matter to relate these differing forms to their correct species. None produce the free-swimming ciliated germ cells that characterize the brown seaweeds. Only one of two characteristic seaweeds from the various zones will be touched on in what follows or such as have unusual beauty of form or colour, or possible commercial uses.

(1) Red Algae of Upper Tidal Zone

Few red algae can endure long periods of exposure to the air such as necessarily occur on exposed rocks of the upper tidal belt; nor, indeed, would one expect to find any red seaweed at all in such places. Yet several

grow nowhere else, though, as might be expected, these are more numerous in the cooler waters of Otago than on Auckland coasts.

Commonest of all such is the MOSS-WEED (*Bostrychia arbuscula*) which, though present on intertidal rocks near Auckland, nowhere attains the abundance or physiognomic importance assumed on southern coasts. At Bluff, for instance, it forms quite a conspicuous zone on the upper tidal rocks. Several other species occur in the same belt but are both smaller and less common.

To the endemic genus *Apophlaea* belong two species, one confined to the North Island and the other to the South Island and Stewart Island. The larger of the two (*A. lyallii*) has short, horny, rigid stems growing in tufts about an inch to two inches tall, and dull fleshy red in colour. It is common on Southern Coasts whereas *A. sinclairii* is found only on high-tide rocks from Wellington north. It forms even smaller tufts which when dry look almost black.

(2) **Red Algae of Lower Tidal Zone**

The most characteristic red seaweed of this zone is the PURPLE LAVER (*Porphyra columbina*) or KARENGO of the Maoris. When the tide is out the broad thalli lie spread over the rock surfaces like sheets of oiled silk, to walk over which is highly dangerous because of their mucilaginous outer surfaces. The old-time Maoris used the karengo both as a food and as the Americans use chewing gum. The lower rock pools may contain a varied assemblage of small epiphytic species but much the most abundant and constant representatives are the various corallines including the encrusting species like the *Melobesias* and stony *Lithophyllums,* and the branching *Corallina officinalis.* This last also

forms a dwarf carpet on exposed rocks with or without erect branches. Of the epiphytes the delicate *Aphanocladia delicatula* has branches as fine as gossamer, while *Cyclocladia umbellata* has much-forked fronds, each stem terminated by a cluster of three or four sac-like branches. The stems are constricted at intervals, so that the swollen water-filled internodes resemble nothing so much as miniature clusters of sausages. Both of these together with species of *Plocamium* are common at Lyall Bay, Wellington.

(3) **Red Algae at Low-water Level**

Red algae become increasingly common as low-water mark is approached and still more so in the first fathom below this. Two leathery dull red algae on rock platforms at low-water are *Pachymenia himantophora* in northern waters and the corresponding *P. lusoria* on southern shores. They are both strap-shaped plants of the surge channel with numerous lateral lobes frequently developed on one side only of the primary thallus. This is also a zone where several species of dulse (*Gigartina*) are to be seen, especially in the quieter waters and on shelving rocky shores. Other common seaweeds include *Callophyllis hombroniana* and *C. calliblepharoides*, the first a large purplish-red alga of southern waters in particular, *Cladhymenia oblongifolia*, also large and strap-shaped, and other tough leathery species designed to withstand considerable rough treatment especially in stormy weather.

(4) **Red Algae immediately below Low-water Level**

In this category we include the generality of red algae between low and deep water. A few may occasionally be exposed to the air for brief periods during spring tides, but the majority are perpetually submerged. Here

belong the COMB-WEEDS (*Pterocladia*) and numerous species of Gigartina, the WIREWEED (*Melanthalia*), the very handsome *Euptilota formosissima*, various ROSE-WEEDS (*Hymenena*) and species of *Callophyllis* and *Plocamium*. At the lower levels in sheltered waters the

FIG. 8. A common Red Seaweed of surge channels (*Melanthalia abscissa*)

beautiful *Laingia*, the handsome *Myriogrammes* and *Nitophyllums*, and other membraneous species abound since, as the water is not much disturbed in normal weather, delicate tissues are not damaged and tough tissues serve no purpose.

The immense masses of NEW ZEALAND DULSE or CARRAGEEN (*Gigartina*) exposed in some areas are now being harvested for the preparation of sea-meal. This country is the apparent headquarters of the genus, having no fewer than thirty species. The stems and branches may be cylindrical, channelled, or flat; or there may be a broad thallus and no stem. This may be strap-shaped and lobed, or (e.g. *G. circumcincta* or *G. apoda*) the leafy frond may resemble, in shape and in size, the leaf of the garden dock. On South Island coasts, the polymorphic *G. clavifera* is much the most common species; but near Auckland other species are more common, as for example *G. alveolata,* though this tends to grow in more shallow water, or even above low-water levels.

The comb-weeds (*Pterocladia*) are mainly North Island seaweeds which grow in immense quantities, especially on the east coast, and which are harvested for the manufacture of agar, which, prior to the recent war, had to be imported from Japan. The species with the greatest commercial value is the larger *P. lucida* which ranges south as far as Kaikoura, but it occurs sparingly in the South Island.

The wireweed (*Melanthalia abscissa*) is another abundant North Island seaweed especially of surge channels, easily recognised by its bushy habit and wiry leafless stems, almost black when dry. Here, too, one meets the red ink weed (*Spongoclonium*) which rapidly stains whatever it touches a bright red. The red pigment of a number of seaweeds is soluble in fresh water but insoluble in salt water. Though not a deep-water seaweed, we may mention here a red alga always found on the fronds of the bull-kelp, which when floated on to a white card looks more like a painting than a real plant. This (*Porphyra subtumens*) is a beautiful

FIG. 9. Red Seaweeds

1. *Ptilota formosissima;* 2. *Callophyllis erosa;* 4. *Sarcodia* sp.; 6. *Apophlœa lyallii*; 3, 7, 8 not determined

plant when so mounted, but a slimy unattractive looking plant when examined in a hand specimen.

(5) Red Algae of Deep Water

Because deep water is undisturbed by normal surface waves the seaweeds growing on the seafloor are commonly membraneous or of delicate constitution, and are obtained only by dredging or in beach drift following heavy storms. This, combined with the bright crimson, pink, purple, or rose shades common to most deep-water seaweeds, results in the presence there of the most beautiful of this group of algae.

Locally abundant are colonies of the CRIMSON TAPEWEED (*Stenogramma interrupta*), so named because the midrib is not continuous. The fronds are thin, flat, and of uniform width, with dichotomous branching. The FEATHERY PTILOTA (*Euptilota formosissima*), *Callophyllis erosa* and *Rhodymenia* spp. are common species in beach drift. The first of these is easily recognized by its dull red colour and numerous, equidistant branches spaced about two millimetres apart.

Of the more membraneous deep-water forms, some of the more attractive will be found in the genera *Nitophyllum, Hymenena, Myriogramme, Delesseria,* and *Laingia.* Many of these are strengthened by a central midrib.

At Titahi Bay near Wellington the writer has observed in the beach drift considerable quantities of a rather pretty seaweed known as *Asparagopsis armata.* Each plant comprises a central stem six inches or more long, closely surrounded by short branches bearing filamentous hairs. When this is immersed or mounted on white paper it is highly ornamental.

CHAPTER II

THE FUNGI

In his *Handbook of the Flora of New Zealand* Hooker says: 'New Zealand no doubt contains several thousand species' [of fungi]. It is considered that fungi are direct descendants of algae or seaweeds, but that they have somewhere in the process lost all trace of chlorophyll, and hence have been reduced to a state of dependence on other plants or animals or their products, for the necessary carbohydrates they cannot themselves elaborate. The majority of fungi to-day are terrestrial, or parasitic, or saprophytic on plants, but while aquatic fungi still exist, on the other hand all stages of adaptation to withstand severe desiccation and prolonged drought are met with. Quite a large majority of 'native' fungi are also inhabitants of lands beyond New Zealand.

Fungi develop from spores, first forming a vegetative portion or mycelium consisting of numerous fibres or hyphæ and later a fructification containing spores. The so-called toadstools, mushrooms, puffballs, and bird's-nest fungi are in fact only the fructifications of various fungi of which the mycelium has developed previously in the tissues of the host or in the substance of some organic product. No fungus can grow in soil after the manner of a tree or a shrub. Always the mushroom bursting through the surface has its mycelium in some organic substance present in the soil.

Fungi have several different modes of reproducing their like; however those to be mentioned in the following notes all belong to one or other of two

groups, the first of which (the *Basidiomycetes*) has naked spores carried at the ends of minute stalks or basidia, packed as a rule so close as to make a continuous spore-bearing surface. To this group belong the mushroom, toadstool, and the bracket fungus. Fungi of the second type (*Ascomycetes*) have the spores encased in small sacs or asci, and to this group belong the morels, bird's-nest fungi, peach leaf-curl fungus, vegetable caterpillar fungus (*Cordyceps*), etc. Most fungi have the spores disseminated by wind and air currents, though a few, in virtue of either a bright colour or strong odour, or both, attract insects, which in turn carry away the spores adhering to their bodies.

Turning briefly to our local fungus flora we may note, as in the case of the mosses and seaweeds, that New Zealand claims some of the world's giants as well as many of the dwarfs. Every size, colour, shape, and hue; every grade of hardness, deliquescence, toughness, brittleness, or beauty is met with in our fungi.

Thus we have *Secotium erythrocephalum* crimson as blood; *Hygrophorus cyaneus* blue as the sky; *Daldinia* black as coal; we have the edible mushroom and the poisonous *Amanita*; we have the giant puffball (*Calvatia*) sometimes as large as a marrow, and we have agarics with caps less than an eighth of an inch; we have fungi of every conceivable form, some like stars, or flowers, or wineglasses, or the nests of birds, or even human ears, and Derwent potatoes. There are hundreds of microscopic fungi, many causing damage to crops and other economic or native plants, which for the present we must ignore, but there are also hundreds of fungi easily detected by the unaided eye.

To facilitate identification and to show the relationships of the numerous fungi, they, in common with other sections of the plant kingdom, are broken up into

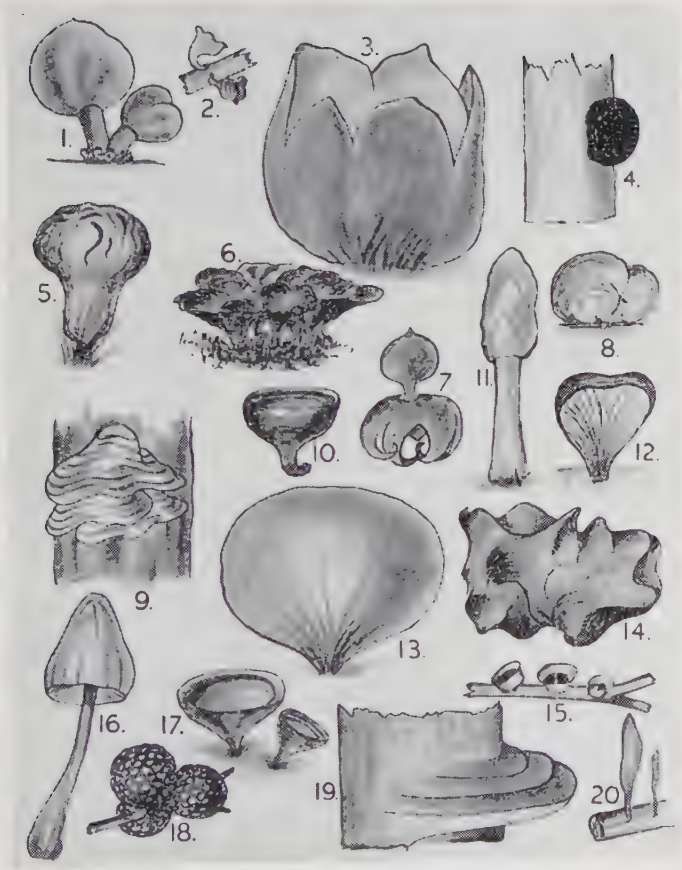


FIG. 10. New Zealand Fungi

1. The Red Secotium (*S. erythrocephalum*). 2. Bird's-nest Fungus (*Cyathus hookeri*). 3. The leather Jacket (*Mycenastrum corium*). 4. Charcoal Fungus (*Daldinia concentrica*). 5. Puffball (*Lycoperdon perlatum*); 6. Corky Spine Fungus (*Hydnum sp.*). 7 Earthstar (*Geaster perlatum*); 8. *Paurocotylis pila*. 9 Bracket Fungus (*Polystictus versipectinatus*); 10. Wineglass Fungus (*Geopyxis sp.*). 11 Lizard Tuft (*Leotia color*). 12. *Schizophyllum commune*. 13 Common Earth-ball (*Sclerolubrica*); 14. Jew's ear Fungus (*Hirneola polytricha*). 15. Bird's-nest Fungus (*Cruciibulum vulgare*); 16. Blue Toadstool (*Hygrophorus cyaneus*); 17. Sooty Elf-cap (*Peziza melastoma*); 18. Strawberry Fungus (*Cyttaria gunnii*); 19. Bracket Fungus (*Fomes eucalyptorum*); 20. Devil's Fingers (*Xylaria sp.*).

major groups progressively subdivided till we reach families, genera, and finally species. Thus the major groups—Basidiomycetes and Ascomycetes—already referred to—are next broken up into some fifteen smaller groups (ignoring the thousands of microscopic fungi—smuts, rusts, etc.). Using popular names as far as possible the following table shows these major groups:

BASIDIOMYCETES

(a) **Hymenomycetes**

(1) Agarics	-	Toadstools and other gilled fungi.
(2) Polypores	-	Penny Bun, Bracket Fungi, and others with spore-lined open tubes.
(3) Thelephores	-	*Stereum* and other primitive genera with spores on all exposed surfaces.
(4) Spine Fungi	-	*Hydnum, Irpex,* and other fungi with spores on spines or teeth on lower surface.
(5) Club Fungi	-	*Clavaria* and similar club-shaped or branched fungi sporing on all exposed surfaces.
(6) Gelatinous Fungi		Jew's-ear Fungus, *Tremella, Calocera,* etc.

(b) **Gasteromycetes**

(1) Subterranean Fungi	-	*Rhizopogon,* Beech Potato, etc.
(2) Scleroderms	-	*Scleroderma,* etc.
(3) Bird's-nest Fungi	-	*Cyathus, Crucibulum, Nidularia,* etc.
(4) Puffballs	-	*Lycoperdon, Calvatia,* Earth-stars, etc.
(5) Phalloids	-	Stink-horns, Flower Fungus, Basket Fungus, etc.

ASCOMYCETES (with spores enclosed in asci).

(1) Morels, etc.	-	*Morchella, Helvella, Geoglossum,* etc.
(2) Cup Fungi	-	*Peziza, Geopyxis, Sepulcra,* etc.
(3) 'Charcoal' Fungi		*Daldinia, Xylaria,* Ergot, Vegetable Caterpillars, etc.

The Membrane Fungi

The agarics or gilled fungi are popularly known as toadstools when the cap is circular and carried on a central stalk, though some polypores have a similar shape and are similarly named. Amongst the hundred and fifty or more species are a small number with lateral or eccentric stems or even no stems at all. The only requirement is that they carry the spore-bearing 'hymenium' on the surface of gills or plates on their lower surface.

Agarics are primarily classified according as the spores are white, pink, brown, purple, or black, best discovered by placing the cap on a sheet of paper and covering for a day or more with a glass tumbler, when the spores will have formed radiating lines on the paper enabling the colour to be easily determined. Subsequent division into genera depends on the presence or absence of a ring on the stalk, of the shape of the cap and gills, and similar features.

The two largest agarics are probably introductions from Great Britain, namely the HORSE-MUSHROOM sometimes a foot in diameter, and the SCARLET FLY-CAP (*Amanita muscaria*) a brilliant but highly poisonous toadstool common under pine trees about Wellington.

Much more common is the HONEY TUFT (*Armillaria mellea*) a yellowish agaric growing in compact clusters on or near the bases of forest trees. It may be identified by the white spores, yellow caps up to three inches across, ringed stem, and adnate gills as well as by the 'black cord-like strands running between the wood and the bark, or travelling in the ground from one tree to another'.

Agarics in common with other fungi have a total lack of chlorophyll so that they must live either a saprophytic or a parasitic existence on plants or animals, their remains, or excrement. A mushroom growing in the field does not gather its nourishment from the soil but from organic matter buried in the soil. It is therefore in the forests that we must search for a majority of agarics, though not a few are pasture plants.

A number for obvious reasons are known as SHAGGY-CAPS. The commonest of these, (*Pholiota adiposa*), like the honey-tuft, is a tufted species that grows on upright trees. The stalks all bend upwards to support

a yellowish or brownish cap with rings of regularly spaced scales, and brown spores. Species of *Russula* are often brightly tinted. They have unusually thick but brittle stalks and equally brittle gills. Some genera have funnel-shaped caps and gills that are decurrent along the outer surface of the funnel. Such are species of *Cantharellus, Clitocybe,* and *Omphalia.* Some are conspicuous in colour as well as in shape.

Schizophyllum and *Panus* have fan-shaped 'pilei' attached to logs by the base of the fan, the former being distinguished by the split edges of the gills. These, unlike the majority of agarics, become leathery when dry, and are long persistent, whereas most of the others are rapidly destroyed by insects or bacteria. The species of *Coprinus* are black-spored, delicate agarics living on animal manure and deliquescing into a liquid at maturity, whence the popular name of INK FUNGI. A useful key to the New Zealand genera of agarics is given by Dr. Cone in *Bulletin No.* 20, Wellington Botanical Society.

Polypores

Passing on to the 'polypores' or those fungi in which the hymenium lines minute hollow tubes or pits opening on to the lower surface, we find two main types—one group resembling an agaric with stalk and cap, the other forming lateral or overlapping brackets on trees and logs. The brackets may be hard and woody with the tubes in stratified layers (*Fomes* spp.) or they may be corky or leathery with a single layer of spore-bearing tubes (*Polyporus* spp.). A number of polypores are everywhere attached to the substratum (e.g. *Poria* spp.).

Some species of Fomes (e.g. *F. hemitephrus*) are saprophytes on dead wood of beech and other trees, while others like *F. australis* and *F. robustus* are common parasites causing heart-rot in living trees.

Apparently two layers of stratified tubes are formed annually in the first-named species, which alone has a white lower surface, that of other species being brown. Brackets up to a yard in width occur in *F. australis.*

Most of the seventeen species of *Polyporus* are saprophytic on dead forest trees, logs, or tree stumps, only two being parasitic. Thus *P. eucalyptorum* causes heart-rot in beech trees, and *P. versicolor* is a wound-parasite unable to attack living trees save through wounded stems or broken bark. This latter—the RAINBOW FUNGUS—derives its popular name from the concentric zones of various colours on the upper surface of each bracket. Usually there are dozens of overlapping brackets in each colony.

The genus *Trametes,* distinguished by the uneven length of the tubes, has one very conspicuous representative commonly noted around Wellington, conspicuous because of its bright vermilion colour. This is *T. cinnabaroides,* each ear-shaped bracket about three inches wide and attached to pine-tree stumps or dead logs by means of a narrow but thick corky base.

The PENNY BUN (*Boletus edulis*), so very abundant in pine-tree plantations, is the best known member of the fleshy mushroom-shaped polypores. The surface of the cap is brown and glutinous and is separated from the bright yellow spore-bearing lower stratum by a layer of white edible flesh. The mycelium of this fungus forms a mycorrhizal association with the roots of the pine.

The SPINE FUNGI are not numerous, most being species of *Hydnum.* The largest (*H. coralloides*) is a fleshy, much branched, white fungus with numerous, pendulous, spore-bearing spines, usually located on the undersides of fallen trees or logs. A much smaller yellow species (*H. wellingtonii*) is occasionally encountered.

THELEPHORES are represented by species of wood-frequenting *Stereums* and by a score of less well-known genera. Next come the numerous STAGHORNS (*Clavarias*) with erect club-shaped or branching fleshy sporophores usually forming dense tufts. Mostly they are yellow or orange or purplish in colour or even white, but are never black. Finally, we have a group of fungi gelatinous when moist, but usually leathery when dry, of which the JEW'S-EAR FUNGUS (*Hirneola polytricha*), the contorted, yellow *Tremella lutescens,* the tiny orange-red *Guepinia pezizaeformis* with leathery, saucer-shaped velvety 'fruits', the horny, orange-yellow *Calo-ceras* club-shaped or branched, and the world-ranging *Auricularia mesenterica* are typical members.

The Jew's-ear fungus, so abundant on mahoe and other forest trees, was formerly shipped by the ton to China for making soups. The *Auricularia* is much less common in New Zealand. The lower part is glued to the bark with the upper portion forming a protecting umbrella over the gelatinous, purple, much-ribbed hymenium below.

The Pouch Fungi

As mentioned earlier these fungi do not expose the spore-bearing basidia till maturity. Most of the first group develop below the surface of the ground and only emerge when the spores are ready for dispersal. Nine such genera are represented in our flora. They have no supporting stems. The most conspicuous of these is the violet-tinted BEECH POTATO (*Hysterangium sclero-dermum*), a tuberous-looking fungus resembling a small Derwent potato. The white, lobed *Phallobata alba* grows in small colonies on rotting wood. *Rhizopogon rubescens* has a more globular form and a dull reddish tint, has the surface covered with branching, vein-like

fibres, and has yellow flesh later turning to pale green. The second group includes four species of *Secotium* with brightly coloured caps on a central stem. Three species call for special mention. The SCARLET SECOTIUM (*S. erythrocephalum*) is a very common forest species usually growing in small colonies with brilliant red caps supported by a white central stalk an inch or more long. In the author's garden this fungus appears annually, though far removed from any forested area. It is very similar in size and also in colour to a stalkless forest fungus known as *Paurocotylis pila*. The PURPLE SECOTIUM (*S. porphyrium*) is a larger but equally beautiful fungus of beech forest floors, the third being the GREEN SECOTIUM (*S. virescens*) with a less vivid greenish or bluish elongated cap, whereas it is rather globular in the other two species named above, convoluted in the first, smooth in the second.

Group two is a small one containing more or less globular 'puffballs' (*Scleroderma* spp.) with a thick-walled peridium, the name given to the wall of the spore-bearing capsule. In order to liberate the blackish spores the apex ruptures irregularly. The fungi of this group develop above ground and also differ from those of the first group in the possession of a stem-like base. *S. vulgare* is the best known of these, being a yellowish or brownish puffball, one to three inches in diameter, and covered with exterior warts or scales.

Passing on to the BIRD'S-NEST FUNGI of which three genera are represented in New Zealand, much the commonest of seven species is *Crucibulum vulgare*, a small, white, cup-shaped fungus containing a number of spore-filled 'eggs' and attached usually to twigs but also to leaves or manure. Though each cup is only a quarter of an inch or less in diameter, the fungus usually grows in colonies, which greatly aids in their discovery.

The fungi comprising the fourth group are the true puffballs and earth-stars, belonging mainly to the genera *Lycoperdon* and *Geaster* respectively. The species of *Lycoperdon* are mostly so variable that individual species cannot always be readily identified. They all have a double coat, the outer of which frequently breaks up into patches or scales, and a terminal pore through which the dry spores readily escape. On the other hand, the earth-stars have three coats, two of which, still united, split into segments which bend downwards to form the star leaving the third coat still forming a central spore-containing puffball. These fungi develop underground, so that the later development of the star ensures that the puffball is not covered, so preventing spore dispersal. Commonest of the forest dwellers is *G. velutinus,* a species that does not develop below the soil, but under the detritus lying on the forest floor. The commonest species in garden or under hedgerows is *G. pectinatus.* The LEATHER JACKET (*Mycenastrum corium*) is a large brown puffball of which only the base remains when the spores have gone, but it belongs to the former group. Much the largest of the puffballs is *Calvatia gigantea,* often larger than a pumpkin.

Those who desire further information are referred to Vol. 57 of the *Transactions of the New Zealand Institute* where Dr. Cunningham describes and illustrates all the New Zealand species of puffball and earth-star.

Included in the fifth and last group are the Phalloids to which belong such conspicuous fungi as the SCARLET STINKHORN (*Aseroe rubra*) and the BASKET FUNGUS (*Clathrus cibarius*). *Aseroe* is a flesh-red, funnel-shaped fungus with forked rays spreading from the upper lips resembling nothing so much as a sea-anemone. Both the colour and the vile, foetid odour serve to attract

flies which feed on the slime and so act as carriers of the spores to initiate a new cycle somewhere else. The same thing happens with the other fungi of this group, all of which emerge from a subterranean 'egg' (volva) when the spore mass has matured. The BASKET FUNGUS or LATTICE FUNGUS spreads its globular latticed network into a conspicuous white, slimy structure with an unpleasant odour, that never fails to amaze its beholders. Its miraculous and sudden appearance caused the ancient Maori to term it 'thunder dirt'.

W. Martin, del.

FIG. 11. *Aseroe rubra*, an evil-smelling forest fungus, natural size

The final section of the fungi comprises all those fungi, microscopic or large, which develop the spores—usually one to eight—in elongated cells called asci.

The fruiting body for that reason is called the ascophore. There are four main groups or families of these fungi which are large enough to be visible to the unaided eye, and of which there are New Zealand representatives in at least three of the four divisions. The writer has never found, or heard of, any truffles in New Zealand, but as these never come above ground, and are eaten and dispersed only by animals, their absence would not be surprising as we have never had any land mammals to perform this necessary function.

Firstly we have the morels, lizard-tufts, and *Geoglossums,* but these are not numerous. At least two morels are occasionally observed, the first being the English edible MOREL (*Morchella esculenta*) with a globular ascophore surrounded by a network resembling honeycomb and the other (*M. conica*) a tiny member with an elongated cap and a more uneven network. Allied to these is another brownish fungus (*Geomitra esculenta*) with brain-like folds in place of the honey-comb cells. It is a rather large fungus measuring two or three inches in diameter, and prefers sandy soil in groves of pine trees, a fact that suggests it may be an introduced rather than an indigenous species. In North Island forests the English LIZARD-TUFT (*Leotia lubrica*) is occasionally noted, its yellowish stalk supporting a small, greenish yellow, wavy cap rarely wider than half an inch. *Geoglossums* are represented by several black, erect, club-shaped fungi springing from the soil or dead wood.

The CUP FUNGI are numerous, some black and others richly coloured; some saucer-shaped, others formed like a wine glass, and yet others of rather irregular shape. At least one species of *Sepultaria* occurs on coastal sandhills in Otago. This appears on the surface only at maturity, when it bursts at the tip allowing the

segments to bend back as in the earth-stars and for the same reason. It is a dingy fungus quite unlike several forest-frequenting cup fungi. One representative found in the forest at Days Bay near Wellington, though black, had a beautifully symmetrical wineglass form and stood about an inch high on the forest soil.

We have a number of black fungi of which the CHARCOAL FUNGUS (*Daldinia*), the black but white-fleshed DEVIL'S FINGERS (*Xylaria*), the curious VEGETABLE CATERPILLAR FUNGUS (*Cordyceps* spp.), and ERGOT (*Claviceps*) are the best known. The first of these forms globular masses of the size and shape of a walnut or bigger on standing trees. Devil's fingers are rather club-shaped fungi an inch or two high which protrude from dead logs and are distinguished by the white flesh and black coat. The VEGETABLE CATERPILLAR results from the subterranean caterpillars of moths, usually known as *Porina* spp., being attacked by the mycelium which gradually replaces the tissues till finally a fungus retaining the form of the caterpillar results. At this stage a stalk up to six inches long protrudes from the soil bearing at its tip the spore mass which ensures the survival in time of the fungus. Several other insects are similarly attacked by other species of *Cordyceps*.

Many fantastic conceptions as to the nature and origin of these vegetable caterpillars have from time to time been advanced by puzzled observers; and in the thermal area of the North Island they are frequently gathered and sold to tourists as curios. When the fungus has used up its supply of food and replaced the animal tissues with its own mycelium, it sends up the spore-bearing stalk not unlike a tiny bulrush, so as to secure its own distribution in time and space.

Finally, there are those curious, yellow, spherical 'fruits' of the so-called beech strawberry (*Cyttaria gunnii*), a fungus which attacks the silver beech. These strawberry-like fruits form clusters on the twigs at the ends of the branches, their honey-combed surface making recognition easy and certain. *C. nigra* and *C. pallida* are further parasites of the silver beech but are apparently less common.

Ergot is the sclerotium of a species of *Claviceps* which attacks the seed heads of marram grass, meadow fescue, and other grasses.

CHAPTER III

LICHENS

LICHENS ARE SPORE-BEARING PLANTS of lowly organization found in all latitudes, and at all altitudes wherever rocks are exposed. They are to be found attached to earth, stones, brick walls, dead logs, living trees, or on the bases of tussock grasses. Many species form the round, crustaceous patches seen on the surfaces of rocks where they have the reputation of being able to withstand drought and desiccation for a longer period than any other plant. Others have no defined shape and form scaly, granular, or continuous patches of various colours on rocks, logs, or bark. Some form large leafy expansions attached to tree or rock either by the whole lower surface or by a comparatively small base. Yet others take on a shrubby form, either tufted, erect, or pendulous.

The modern lichenologist takes notice, not only of the shape of the lichen, but of the number and shape of the spores, the nature of the fruiting body, and of the component algae which are present in every lichen, when drawing up his schemes of classification. It will serve present purposes to consider the lichens under the divisions indicated below, viz.:

(1) Crustaceous Lichens
(2) Foliose or Foliaceous Lichens
(3) Fruticose or Shrubby Lichens

Some occupy midway positions and a fourth group could be added—

(4) Squamulose or Scale-like Lichens

First, however, it may be well to make some general observations. Every lichen differs from other plants in being a dual organism built up of a fungus, and a species of alga, usually microscopic in size but numerous in individuals. Being devoid of chlorophyll, the fungus depends on the algae for its carbohydrates, and in return supplies the algae with water and mineral salts as well as affording protection. Living as they do in intimate association for mutual benefit they present a fine example of symbiosis.

It is clear that many lichens can thrive in places where neither the component algae nor the fungi could survive, for they form the last visible outposts of the land-plants as we approach the poles, scale the mountain peaks, descend to the sea, or invade the torrid, tropical deserts. Many, even in New Zealand, can remain dry as dust, and brittle as glass for months on end, and resume normal growth on the return of moister conditions. They are indifferent to normal extremes of heat and cold.

Notwithstanding this dual nature, every lichen composed of a specific fungus and alga maintains a moderately constant, characteristic form. Lichens may therefore be divided into families, genera, species, varieties, and even forms, as other plants.

The main body of the lichen, whatever its shape, is the thallus; and the conspicuous discs seen on the surface or margins are apothecia, containing the fungus spores; but some lichens have closed urn-like 'fruits' opening by an apical pore. Such 'fruiting' organs are termed perithecia. The spores when liberated, being those of the fungus only, cannot initiate a new plant save in close contact with the appropriate alga. It is believed that one species can even give rise to a new species if a different alga is 'captured' from that of the

initial plant. Fortunately, algal cells are amongst the most widespread of all forms of plant life, being found in oceans, rivers, soil and air.

A further means of propagating lichens is by means of soredia, small clusters of algal cells and associated fungal threads (hyphae) which occur on the upper surface or margin of the thallus of many lichens, forming a dusty powder.

Several botanists of world renown have commented on the great wealth of lichens that inhabit New Zealand, and on the inclusion amongst these of some of the largest, handsomest, and most interesting of all known species. A large number are cosmopolitan, being found in suitable localities throughout the world; others have a very wide distribution in southern lands generally, or in Australia and New Zealand in particular. Many others are found only in this country.

Amongst the six hundred known species (and it seems certain there are scores of others as yet unidentified or even collected) there will be found great variation in size, form, colour, and structure. Many crustaceous species are responsible for the splashes of colour on the trunks or stems of forest trees, on rocks, clay banks, and such places. The pendulous *Usneas* give an uncanny aspect to many a subalpine forest scene, while the leafy *Stictas* and *Parmelias* add an equally distinctive touch to many a lowland forest interior.

Now, though lichens may range widely over the earth, most species show a preference for particular stations and substrata. One would never expect to find a *Cladonia* on the twigs of a forest tree, but would not be surprised to find a *Parmelia*; nor would *Lichina* be found on alpine rocks, though it occurs on coastal rocks. Some lichens grow only on rocks, some only on tree

trunks or stems, some only on leaves, and some only as parasites on other lichens. On the other hand, many lichens—*Parmelias* and *Stictas* for instance—grow equally well on trees or rocks. Peat bogs have their characteristic lichen flora, as do limestone rocks, or rocks just above high-tide level.

Thus the New Zealand lichens comprise all types—tropical, temperate, and arctic; coastal and montane; corticolous and saxicolous (living on bark or rock); cosmopolitan and endemic, the giants and dwarfs—and deserve more attention than they have hitherto received.

The algae present in lichens are either green or blue-green in colour. Those lichens containing the mucilaginous alga known as *Nostoc* (e.g. *Collema* or *Leptogium*) will be somewhat gelatinous when moist, as will those containing *Rivularia* (e.g. *Lichina*). Some species of *Sticta* contain blue-green algae and others (usually bright green when wet) contain green algae. We will now note some typical lichens of the three main groups previously mentioned.

(1) **Crustaceous Lichens**

The species in this group outnumber all others combined. It is scarcely possible without microscopic examination and a good 'key' to identify a majority of these, nor even then without reference to previously identified specimens; hence remarks here will be mainly general.

The largest crustaceous genera in New Zealand are *Lecidea* with sixty known species, *Pertusaria* with forty, *Lecanora* with thirty, and *Caloplaca* with twenty in round numbers. The *Lecideas* grow in some cases on bark, but a majority grow on rock. Some have soft, rather waxy apothecia (subgenus *Biatora*) but a majority have black, carbonaceous apothecia of small size (rarely more than 2 mm.), usually with a rim of

the same colour, but only a specialist can distinguish the numerous species.

The various species of *Caloplaca* are usually tinted yellow, red, or orange and though frequently of small size are quite conspicuous. The *Pertusarias* are distinguished from the previous group by the existence on the surface of warts or protuberances each enclosing an immersed apothecium with simple spores. As a rule the thallus is whitish or grey in colour, while the fruits may occasionally be abortive. They are mainly epiphytes.

Lecanora is a genus of lichens having simple spores (8 in each ascus) and apothecia with a border of the same colour as the thallus. Thus the apothecia which may be brown, black, yellow, etc., usually have a prominent rim of a different colour. Normally these are very numerous and of variable size, the largest near the centre. A very prominent and beautiful lichen related to the *Lecanoras* is that known as *Haematomma puniceus* with bright pink apothecia. This is very commonly found associated with *Usneas, Ramalinas,* and *Teloschistes* on smooth-barked trees such as oaks, willows, walnuts, broom, etc.

Coastal rocks are often tinged white or greenish-grey with one or other of a number of species of *Verrucaria,* several recognised by their areolate surface, each areole bearing hemispherical, spore-producing perithecia opening by a pore or slit at the surface. *Verrucarias* are rarely found elsewhere than on rocks, especially coastal rocks. Here too *Xanthoria parietina,* with vivid yellow, red, or orange thalli and apothecia, is usually conspicuous.

Both on coastal rocks and on the bark of trees and shrubs one frequently observes small black lines closely spaced in various patterns. These are the linear

apothecia of lichens known as SCRIPT LICHENS (*Graphis, Opegrapha,* etc.). In some cases the lines are straight, in others branched, in others curved; but, though species appear numerous, no one has as yet investigated the identity of more than two or three. In the case of some species, the thallus lies below the surface and only the apothecia are visible.

There is a conspicuous ground lichen usually observed on clay banks, but not uncommonly on rocks, and even on tree bases, with a whitish or greenish, crustose, granular thallus from which arise beautiful pink or reddish apothecia on short, pink or white, smooth stalks and known as *Baeomyces*, of which the two commonest of six indigenous species are *B. fungoides* and *B. heteromorphus,* the latter commonly with brown rather than pink apothecia.

(2) **Foliose Lichens**

Lichens of this group are much the largest and most conspicuous in our lichen flora. Most may be described as leafy, even though no lichen ever possesses true leaves. Largest of all belong to the genera *Sticta* and *Parmelia,* specimens over a square foot in surface being occasionally observed. Of the *Stictae* the eminent Scottish botanist, Dr. Lauder Lindsay, once wrote: 'New Zealand is *par excellence* the country of the *Stictae*. Not only do they occur in the greatest absolute as well as relative numbers, but there they attain their maximum development, size, and beauty. This preponderance of the *Stictae,* their frequent size, and beauty of colouring, and the profusion of individuals, give a somewhat peculiar character to the foliaceous lichen flora of New Zealand'; but with equal truth he also remarks that 'The *Stictae* are one of the most variable and puzzling groups of the higher or foliaceous

lichens. As in other families and genera, extreme forms are sufficiently distinct . . . . Gradation forms exist between all, so that it defies one's power to delimit a species at all.'

Our fifty recognised species are to-day subdivided into six sub-genera, three of which have blue-green algae or gonidia, and three green gonidia. Two members of each group have the characteristic pits on the lower surface from which the name *Sticta* is derived, but the other two lack these and are commonly lumped together under the name *Lobaria, L. adscripta* being much the commonest species. When these pits are empty they are termed cyphellae and when filled with fungal hyphae, pseudo-cyphellae. The various species of *Sticta* always have one or other, but never both; and these may be coloured yellow or white as a further aid in identifying these numerous and polymorphous plants.

Some species are both abundant and easy to recognise; others are less common and not so easy, but most are widespread throughout the three islands. It would serve no useful purpose to name them all—a few must suffice.

Sticta latifrons and *S. filix* are distinguished by having a single small area of attachment, the latter having on the lower surface prominent brown ribs, the nearby areas also suffused with the same colour, a feature absent from the less dissected fronds of the former which has both conspicuous, white cyphellae and large reddish apothecia.

There are also rather similar but smaller *Stictae* with a dark bronzy-red thallus margined with golden soredia and having yellow pseudocyphellae beneath, which are very attractive plants usually found on boulders or rocks exposed to strong light. These are *S. aurata* and *S. crocata,* the latter alone having true

W. Martin, photo

FIG. 12. Foliaceous Lichens—mainly *Sticta fossulata*, and tufts of Old Man's Beard (*Usnea*), on dead tree branches in Stewart Island forest

cyphellae, but otherwise scarcely distinguishable till broken across, the fracture being golden in *S. aurata* but white in *S. crocata*.

One of the largest and certainly one of the commonest species, in bleak locations as a rule, and growing usually on trees but also on rocks, is known as *S. coronata*. Normally this has a dull green thallus with large yellow patches below and bright yellow within. Perhaps the species nearest to this is *S. flavicans*, a lichen having canary-yellow pseudocyphellae, yellowish thallus when dry, and conspicuous marginal isidia (minute coralloid projections), absent from all the previous species. Two other species with similar isidia and specially abundant are *S. chloroleuca* and *S. psilophylla*, the latter more leathery than the former but otherwise fairly similar.

At least six species have numerous shallow depressions separated by low ridges, and all are quite common. *S. carpoloma* has blue-green algae but neither soredia nor isidia. *S. impressa* is very similar, but has true cyphellae which the other lacks. Both have narrow strap-like lobes. As an aid to the identification of the New Zealand Stictae, the reader is referred to an excellent key provided by Dr. H. H. Allan in *Tuatara*, Vol. 2, No. 2. It is important to note the colour and position of the apothecia which may be black or reddish-brown, and either marginal or scattered over the surface.

Another genus with almost as many species in New Zealand, is that known as PARMELIA, the members of which are often attached to the substratum by black rhizoids. There are no cyphellae and the lower surface is commonly black. The thallus may be coloured white, grey, slaty-blue, yellowish-green, or even black, and usually bears conspicuous brown apothecia, though in

W. Martin, photo

FIG. 13. Epiphytic Lichens—*Sticta coronata* and *Sphaerophorus tener* (white)

some species these are rarely produced. Not a few have a copious surface cover of powdery warts or of dusty soredia. One species usually found on rocks at high levels resembles a tuft of black hair as in the genus Ephebe, and in consequence has been named *P. ephebioides*. A not uncommon lichen on beech bark (*P. tenuirimis* var. *platyna*) has a smooth white thallus strongly edged with projecting black rhizoids with pleasing effect.

Many *Parmelias* are cosmopolitan in distribution but others are more restricted, and some are endemic to New Zealand. Most, notwithstanding numerous differences, show a strong resemblance one to the other and can be named *Parmelia* at a glance.

Species of *Parmelia* used for dyeing cloth in Scotland are usually termed crottles, though one or two lichens of other genera (e.g. *Lecanora tartarea*) were included under this name. This lichen was the CUDBEAR of commerce. Eight New Zealand Parmelias (e.g. *P. pertusa* and *P. weindorferi*) have markedly perforated thalli, but *P. perforata*, on the other hand, is so named because the apothecia are often perforated at the centre.

One yellowish related lichen which is common in many South Island localities, lying unattached on the soil surface, once thought to be a *Parmelia,* is *Chondriopsis subviridis*. It is quite a common feature of most unattached algae, lichens, and mosses that they do not fruit.

To the foliose lichens belong also the *Nephromas* and the *Peltigeras,* both of which develop the apothecia at the tips of marginal lobes, the former on the lower surface and the latter on the upper. Of these we have a dozen or more species, the commonest of the *Nephromas* being *N. australe*, which forms extensive patches on forest trees, and *N. lyellii*, often tinted

brownish or blue. Commonest of the nine *Peltigeras* is *P. polydactyla* with numerous finger-like lobes bearing the apothecia. The dog lichen (*P. canina*), a well-known British lichen, is also present. The genus *Solorina* has similar apothecia, central rather than marginal. The sole species is *S. crocea* also found in Europe.

Lastly, we have a number of small alpine lichens with almost black thalli, commonly under an inch wide, which are attached to the rocks only at the centre and which we may group as *Umbilicarias*, though botanists now divide them into three distinct genera. A Northern Hemisphere species is known as ROCK TRIPE.

(3) **Fruticose Lichens**

In this group are placed all shrubby lichens with an erect or pendulous habit. Unlike the foliose lichens of which the majority have tropical affinities, the fruticose species are best developed in the colder regions of the earth. On the northern plateaux of Europe and Asia the principal vegetation covering the ground for square miles at a stretch is mainly lichen heath forming a thick yellowish-grey carpet. On the tundras the lichens are mainly crustose but in sheltered hollows *Cladina* heath takes its place. Most abundant of the fruticose lichens are three species collectively termed REINDEER MOSS (*C. rangiferina*, *C. alpestris*, and *C. sylvatica*) because it forms the staple food of the reindeer when the winter snow covers the ground.

In New Zealand the genus *Cladonia* is represented by between sixty and seventy species including four similar to the reindeer moss. *C. alpestrioides* is common in New Zealand, but the other three are amply distinct from those of northern Europe. Such have their stems and branches (podetia) intimately interlocked, dying at the base but continuing growth at the tips and forming bushy patches in heaths and on bogs.

The fruiting organs (apothecia) of the *Cladonias* usually occur on the tips of the main stem or its branches or on the margin of cup-shaped structures known as scyphi. The colours may be pale or flesh-coloured or even black, but most commonly they are brown or crimson.

Three species have much-branched podetia with numerous perforations on the walls of the hollow stems. Of these, the most conspicuous and much the most attractive species is the lace-lichen (*Cladonia retipora*) with white or yellowish lace-like podetia, soft and pliant when moist, but brittle as glass when dry. It abounds in most manuka heaths, on peaty soils, on stony wastes, and similar places throughout New Zealand in both lowland and subalpine habitats. Somewhat similar but less common is *C. sullivani,* a bog-frequenting species, usually subalpine, but reaching sea level in Southland and Stewart Island. As a rule this is a brown lichen with blackish patches and a black interior lining to the central canal, easily visible through the numerous pores of the podetial walls. Large plants may reach a foot in height but normally it is only two to three inches tall. On Awarua Plain in Southland it tends to be ashy green rather than brown. The third member of the group (*C. aggregata*) takes a great variety of forms generally brown. The perforations may be scanty or numerous and the tips are always sharp-pointed. It is one of the commonest *Cladoniae* in New Zealand and ranges over the Southern Hemisphere whereas the two former species are restricted to Australia and New Zealand.

Fourteen *Cladonias* have scarlet apothecia which in *C. coccifera* and in *C. deformis* are large and very conspicuous; but, whereas the former is rare the latter is very abundant especially on peaty soils amongst

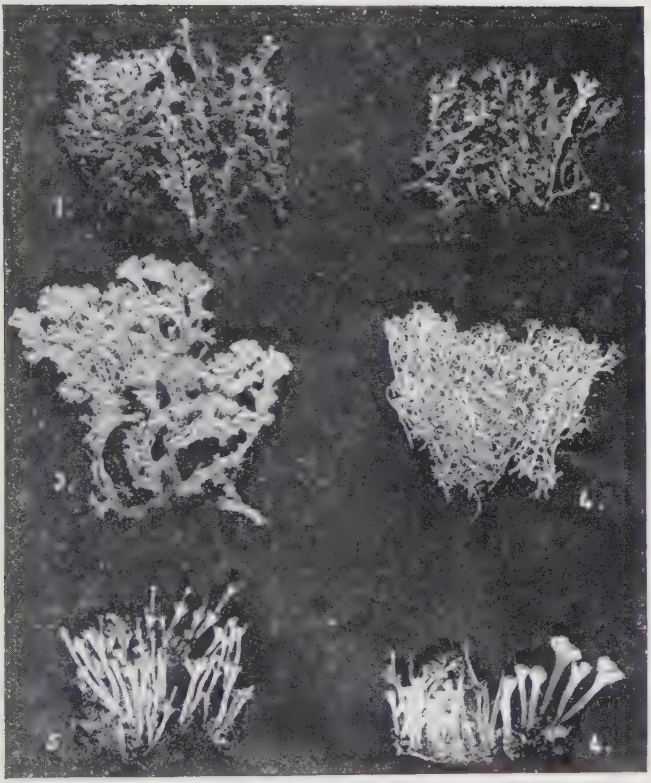


FIG. 14. Fruticose Lichens—genus *Cladonia*

1. *Cladonia sullivani*; 2. *Cladonia aggregata*; 3. *Cladonia retipora*; 4. *Cladonia leptoclada*; 5. *Cladonia verticillata*; 6. *Cladonia pleurota*.

manuka. *C. pleurota* is much like *C. coccifera* but the upper part of the cup is sorediose. These three usually take the form of cups or goblets. Of those that bear the apothecia on the ends of the podetia or branches the commonest are *C. macilenta* and *C. floerkeana*,

and in subalpine stations *C. subdigitata,* a much more robust species.

Most other *Cladonias* have brown fruits at maturity. Among such, *C. verticillata,* with up to six and seven tiers of cups each arising from the centre of the cup below is easily recognized. There is another lichen of similar appearance known as *C. cornutoradiata* which in one of its many forms has a series of three to five cups, but in this case they arise from the margin of the cup below. The more usual form of this plant has tall white podetia several inches high with or without branches in the upper half. There are several *Cladonias* with brown apothecia which take the goblet form. Of these *C. fimbriata* is small and slender with narrow cups; *C. major* is very similar but much larger at maturity. These have a dusty coating of soredia, but in *C. chlorophaea* the soredia are granular, whereas *C. pyxidata* as a rule has short wide cups without soredia but with a tuberculed podetial wall. In all of these the cups are closed by a concave membrane but there are other cup-producing species where the cups are open. Sometimes cups are absent, but a hole may be noted at the angle between the main stem and its branches. Of this group the commonest species is *C. scabriuscula,* commonly a tall plant with curving stems bearing leafy squamules.

Another genus of allied fruticose lichens is known as *Stereocaulon.* Here the podetia are solid, not hollow as in *Cladonia.* Of eight or nine species known in New Zealand the commonest (*S. ramulosum*) is a tall lichen commonly occupying rocky roadside banks and similar places and in such numbers as to constitute a conspicuous grey mat. Rather smaller and more slender but growing in similar stations is *S. corticatulum.* Two species growing on rock have simple stems only a few millimetres tall.

Yet another allied genus of fruticose lichens is represented by a more or less cosmopolitan species known as the worm lichen (*Cerania vermicularis*). This is a subalpine plant consisting of slender, white, usually unbranched podetia which normally lie prone upon the earth in areas of bog or fell-field.

Another family of fruticose lichens contains both the *Usneas* and the *Ramalinas*, the former with cylindrical, green or yellow, thread-like branches, those of the *Ramalinas* being flat and grey-green on both surfaces.

The *Usneas* are sometimes termed AARON'S BEARD LICHENS. The dozen New Zealand representatives include dull green or yellow, tufted species common on post and rail fences, telegraph poles, old apple trees, and on exposed shrubs and tree trunks. Others, usually larger and frequently pendulous, grow commonly on tree tops in subalpine habitats, and when plentiful impart a weird aspect to this elfin forest. They are commonly mistaken for mosses. Four species common on alpine rocks, though yellow at the base are black in the upper portions and constitute the subgenus *Neuropogon*. All species have a tough central strand lacking in *Alectoria nigricans*, another blackish alpine lichen with filiform branches. The apothecia in *Usnea* may be lateral or terminal. They are large, coloured like the thallus and round, usually with a marginal fringe of stiff hairs. Several species, however, rarely develop apothecia at all.

The genus *Ramalina* has ten or more New Zealand representatives, some (e.g. *R. fraxinea*) with broad, strap-shaped thalli, and others (e.g. *R. dilacerata*) with cushion-like tufts comprising closely packed fronds. The *Ramalinas* are common associates of the *Usneas*, especially on shrubs and smooth-barked trees.

Yet another fruticose lichen frequently associated

with *Usnea* and *Ramalina* bears the burdensome name of *Teloschistes chrysophthalmus* for which the name ORANGE CROTTLE is suggested. This is specially abundant on hawthorn and old neglected apple trees especially in regions near the coast. It varies in colour from pale yellow to deep orange often on a single specimen, but the apothecia produced copiously are usually much deeper in colour above and paler below. Leaves and apothecia bear numerous yellow spines. A very conspicuous red, orange, or yellow lichen known as *Xanthoria parietina* is abundant on coastal rocks in both islands.

There are a number of lichens which do not fit well into any of the above categories, the thallus comprising a large number of semi-erect scales or squamules and of these *Pannaria immixta* is probably the commonest member. Among the *Lecidias* a few in the section *Psora,* with coloured apothecia attached to the scales, may also be noted; and doubtless the species of *Sphaeroma* and *Physcia* would also be placed here.

The lichens as a group were amongst the earliest of land plants. Their ability to colonize bare-rock surfaces enables them to prepare a 'soil' with enough organic matter to permit mosses to follow, then ferns, and finally the flowering plants. Many species of *Parmelia, Lecanora,* and others when boiled with caustic potash afford useful dyes, once much used in Scotland and elsewhere for dyeing wool, while several have been used as food, of which the manna mentioned in the Bible is a good example. This is a lichen (*Lecanora esculenta*) 'which rolls, in a detached state, over sandy (African) plains, and is collected as food for men and horses'.

CHAPTER IV

MOSSES AND LIVERWORTS

It was Mr. Menzies, surgeon and naturalist accompanying Captain Vancouver on his famous southern voyage of 1791, who first collected and proclaimed the cryptogamic riches of New Zealand, for it was to the bryophytes (collective name for mosses and hepatics) that he devoted most attention during his stay in New Zealand waters.

Bishop Colenso, another resident admirer and collector of these lowly but beautiful plants, amassed copious collections and had them forwarded to London. His own papers communicated to the *Transactions of the New Zealand Institute* make fascinating reading, marred somewhat by his treating as new species all plants showing trivial deviation from already-named plants.

Many European botanists of note—Hooker, Lyall, Raoul, Berggren, Lauder Lindsay—were early visitors who studied the mosses and hepatics during the first half-century following British occupation. Towards the close of the century, resident botanists—Brown, Bell, Kirk, Petrie, Buchanan, Gray, and Armstrong—had each made further contributions to our knowledge of these plants.

Hooker records: 'The mosses and liverworts are by far the most extensive order of plants except fungi in these islands, as they are of most temperate and especially of moist climates. Mr. Wilson's *Muscilogia of New Zealand* includes 250 species of moss, amongst

which are many of the most gigantic, beautiful, and interesting in structure in the world'. Since then the known species of mosses have been doubled, and together with the hepatics number about nine hundred. Stewart Island alone has over 400 bryophytes.

In a eulogy of von Goebels, the illustrious German botanist who visited New Zealand in 1898, Dr. L. Cockayne has this to say,—"In a moist gully at the base of Mt. Alexander in Westland, crowded with liverworts of every size and shape (many being giants of the family) von Goebels' delight rose to its highest pitch. 'Here,' he cried, 'were it possible for me, I would build a cottage and spend the rest of my life studying the bryophytes in this gully'."

Though much still remains to be done, especially in large unbotanized areas, the moss flora and its distribution are to-day reasonably well known. Thanks to Mrs. E. A. Hodgson, Allison, and others, working in conjunction with overseas students, the hepatic flora is well on the way to being equally well known.

The Mosses

Mosses are commonly confused with other plant families, as may be seen by the fact that Irish moss is a seaweed, reindeer moss is a lichen, the sponge mosses are hepatics, club mosses are lycopods, and golden moss is a flowering plant. With few exceptions mosses are leafy plants giving rise to urn-shaped, spore-bearing capsules with a deciduous lid or operculum and, when young at least, an outer hood or veil (calyptra).

Now lichens never have true leaves, liverworts never have urn-shaped capsules with a lid or veil, and mosses never have true flowers; hence it need not as a rule be very difficult to distinguish a true moss from other plants.

Mosses are found in all parts of the earth save

in deserts. They are to be found in arctic lands, and sometimes on sunbaked rocks; but it is, however, in warm humid forests, in swamps, or in areas subject to frequent fogs that these delicate plants luxuriate. In consequence the humid rain-forests of the North Island and of the West Coast of the South Island are especially rich both in species and in individuals. Indeed, the characteristic vegetation of the forest interior is a complex of cryptogamic plants in which few flowering plants may often be visible. Not only is the forest floor carpeted with bryophytes and ferns, but the trees are usually heavily draped in a mantle of green or brown vegetation in which the bryophytes and lichens are dominant.

Mosses show an advance from algae, fungi and lichens in the possession of a true leaf-bearing stem from which, however, the water-conducting vessels present in ferns, lycopods, and flowering plants are usually lacking. The leafy plant is known as the gametophyte as each plant produces either one or both sex organs. Fertilization is followed by the development of a sporophyte comprising the capsule with its supporting stalk or seta embedded in the tissues of the parent plant and deriving therefrom its sustenance. This sporophyte is not a part of the leafy moss but the daughter generation living on it as a parasite, and producing spores which on germination produce a threadlike protonema bearing buds which grow into leafy moss plants. Thus neighbouring plants may well have had a common spore 'ancestor', the decay of the protonema having destroyed the link between them.

While still immature, and sometimes later, also, the capsule is protected in whole or in part by a covering veil or calyptra. At maturity both the veil and the underlying lid being deciduous fall off, leaving a single

or double fringe of hygroscopic teeth on the capsule margin (known as the peristome), to control the escape of the spores in fine weather or protect them when the conditions are less favourable. These teeth number four, eight, sixteen, or thirty-two.

The spore capsules in mosses that grow erect usually arise from the tips of the stems; but prostrate stems more usually have lateral sporophytes. The position of these so-called 'fruits' is constant for each moss species. Erect stems may be smooth, or clad in a felt of fibres; and the capsules, if erect, will usually have the peristome absent or poorly developed. Mosses obtain their moisture through their leaves, especially by very large cells commonly found at the leaf base. The rhizoids or 'roots' serve only to anchor the plant. The moss leaf is always simple, bearing neither leaf-stalks nor surface hairs; but, unlike the leafy hepatics, many moss plants have a midrib in each leaf or leaves ending in a hair point.

Mosses often multiply vegetatively for every part of the plant seems capable of initiating a new plant under suitable conditions. However, many mosses develop special buds or propagula to ensure vegetative reproduction.

Forest Mosses (a) Forest Floor

New Zealand is at once the home of several of the world's largest, smallest, and most remarkable mosses, and few countries of comparable size can surpass the wealth and luxuriance of its moss flora as a whole.

Of all the ground dwellers in the forest none equals in stature the DAWSONIA or KING MOSS (*Dawsonia superba*), which though native also to Australia and Tasmania, nevertheless reaches its largest dimensions in the forests north of Westland, more particularly the

FIG. 15. New Zealand Mosses

1. *Drepanon calycinum*; 2. *Lopidium concinnum*; 3. *Dendroligotrichum dendroides*; 4. *Campylopus introflexus*; 5. *Cyathophorum bulbosum*; 6. *Cladomnion ericoides*; 7. *Dawsonia superba*; 8. *Sciadocladus menziesii*; 9. *Dicranoloma platycaulon*; 10. *Pterygophyllum quadrifarium*; 11. *Hypopterygium filiculæforme*; 12. *Cyrtopus setosus*.

kauri forests. It commonly forms small colonies at the foot of some forest giant, the stems being rigidly erect and woody and the leaves long and narrow, spreading widely when moist, but closing on to the stem when dry to aid the capillary rise of moisture. They are green when moist, brown when dry. The capsule is large and robust and bent at right angles to the seta when mature, the peristome comprising so many teeth as to resemble a plug of cotton wool. The normal height ranges from eight inches to a foot, but many specimens attain twice that height and even thirty inches. Truly it deserves the alternative name of GIANT MOSS. It is always confined to lowland forest.

The subalpine forests are sometimes carpeted for square yards at a time with the WIRE MOSS, another giant moss bearing the cumbrous name of *Dendroligotrichum dendroides*. Large specimens may have a stem eighteen to twenty inches long, or even more, but normally they are only half as long or less.

This moss has a long, dark, wiry stem surmounted by a tuft of leafy branches, each plant being either male or female. However, the stem is always bent, and recumbent in its lower part, so that the carpet may be only a few inches deep. It usually puts in an appearance as soon as the lowland forest gives way to subalpine forest. It will grow in the open, but only in areas which are shrouded most of the time in mist as on the summit of Table Hill in Stewart Island. Occasionally in Stewart Island or in the West Coast sounds it may even descend to sea level. Capsules are much smaller than in the *Dawsonia* and the setae or stalks are longer.

UMBRELLA MOSSES are rarely found away from forested areas. They are so called because the branches are placed horizontally at the top of an erect stem so as to obtain the maximum light in their shady, secluded

forest stations. Of these the largest is MENZIES' UMBRELLA MOSS, sometimes termed PAGODA MOSS (*Sciadocladus menziesii*). Specially large specimens may attain one foot in height, but in most localities the plants do not exceed three or four inches. It thrives in deep shade on very moist forest floors or on decaying logs. The name, pagoda moss, is suggested by plants which have sent up a stem above the original umbrella to bear aloft a second umbrella. As many as eight such leafy whorls may be noted in Stewart Island forests, each doubtless representing the growth of a new season. A second species (*S. kerrii*) cannot be distinguished from the first save by the capsules which are very short, those of the pagoda moss being long and narrow.

Umbrella mosses belonging to three other genera are equally common. Thus we have *Mniodendron comosum*—the BRONZE UMBRELLA MOSS—not unlike the last but having a 'furry' stem and a furrowed capsule, those of *Sciadocladus* being always smooth. Colonies of this moss are sufficiently attractive to claim the notice of all who stumble across them. Then there are the two species of *Hypnodendron* having furrowed capsules but smooth stems. *H. arcuatum* is usually rather small but is the more common of the two. However, *H. marginatum*—the STILT MOSS—standing erect in forest pools as it commonly does, and bearing as many as thirty capsules in selected specimens held aloft on red setae is one of the handsomest mosses in the flora. It is named after the wading bird from the erect wiry stalks standing in water and bearing the body of the plant well clear of the water.

The remaining umbrella mosses belong to the genus *Hypopterygium* with five New Zealand species, one of which, however, lacks the umbrella form as it grows mainly on trees (viz. *H. concinnum*). It has recently

FIG. 16. Umbrella Mosses on log in Stewart Island forest.

Neozelandia zeelandiae (centre back); *Hypopterygium falcatiforme* (back right) with *Mniodendron comosum*; *Camptochaete arbuscula* (foreground) is not an umbrella moss.

been placed in the genus *Lopidium*. Much the most attractive of the others, and the largest, is the FERN-MOSS (*H. filiculaeforme*) which selects swampy forest floors or shady stations on the margins of forest streams. The leafy branches form a pointed, heart-shaped frond placed horizontally on an upright stem in order to make the best possible use of the diffused light. The individual leaves are very tiny and dark green. Normally each plant is three or four inches tall, but on occasion the stems may even exceed twice this height, each frond rising from a short thick rhizome buried in the mud or soil. The commonest species is the PARASOL MOSS (*H. novae-seelandiae*), a small plant with circular umbrella usually under an inch in diameter and sometimes under a quarter of an inch. Like the previous moss it always grows in colonies.

Equally common on moist forest soils or on decaying logs are two species of WING MOSS (*Pterygophyllum*) with dark-coloured, scale-like leaves overlapping to form flattened branches which early in the season produce numerous fruit stalks and capsules. One is quite a large moss (*P. quadrifarium*), the other a small plant with tiny notched leaves that dry quite black (*P. dentatum*).

Yet another common moss on forest soils but even more abundant on roots and rocks especially near streams is the BRISTLE MOSS (*Echinodium hispidum*). Normally this plant has long cylindrical leafy stems with short, sharp-pointed, narrow leaves, and few branches; but it frequently may be found in large colonies of fully detached plants, lying loose on the surface. In such cases it becomes prolifically branched, completely changes its outward appearance, has smaller leaves, but never any capsules. New plants are produced by individual branches rotting off at the base. The moss

Camptochaete ramulosa is completely analogous in this respect. At least six local mosses can thrive for years though lying loose on the soil surface.

Much the most abundant mosses carpeting the ground in forested areas and particularly in subalpine beech forests are those known as SHAGGY MOSSES (*Dicranoloma*) of which the commonest of numerous species is *D. billardieri*. This moss in Stewart Island and in some subalpine forests of the South Island forms massive mounds usually about a foot in diameter but not infrequently almost a yard across and a couple of feet high, making progress in such areas very tiring and tedious. The sporophytes in this moss occur singly; but in three species several arise from the same 'flower' giving rise to the popular name of GOLF-STICK MOSSES (e.g. *D. plurisetum* and *D. dicarpum*) the former further distinguished by its pale, whitish-green leaves. These mosses all have long, narrow, pointed leaves with a wider base, and a tendency for all to be twisted to one side of the stem. The white-leafed MILK MOSS (*Leucobryum candidum*) common on tree bases and on the drier forest soils could scarcely be confused with any other moss unless perhaps a species of SPHAGNUM.

Forest Mosses (b) Forest trees

Lack of space precludes reference to more than a fraction of the numerous mosses that grow on the trunks and stems of the forest trees. Only the more common or conspicuous will therefore be referred to. Pendulous mosses are not numerous, comprising only two species of grey-green Weymouthias and six of golden or brownish species of *Papillaria*. Occasionally the world-ranging *Neckera pennata* forms drooping sheets against the trunk of some forest tree, but they are rarely obviously pendulous. The SLENDER ELFIN

MOSS (*W. mollis*) is easily recognised from the very slender yellow-green or greyish streamers and soft spoon-shaped leaves. From the ELFIN MOSS (*W. cochlearifolia*) it is distinguished by the thread-like branches. The elfin moss has leafy stems 2 to 3 millimetres wide as against one millimetre of *W. mollis* and much larger cup-shaped leaves; but both have the same yellowish or grey-green colour which at once distinguishes them from any of the Papillarias. The commonest, most robust, and most striking of these is the GOLDEN STREAMER (*P. flavolimbata*) distinguished by its rich orange colour, numerous long whip-like branches, and characteristic habit. The leaves are further distinguished by the presence, on some at least, of branching terminal hairs.

Neckera pennata—the COMMON NECKERA—ranging to Great Britain and North America, is readily known by its beautiful transversely undulate leaves, seen to best advantage under a hand lens, its bright green colour, and its flattened branches. The MIRROR MOSS (*Orthorrhynchium elegans*) is a very pretty though smaller moss with flattened branches closely adhering to the bark, and at once recognized by the extreme glossiness of its boat-shaped leaves which overlap in such a way as to form a continuous edge, and by its very distinctive sporophytes. Very similar to this but distinguished by the projecting leaf-tips is the GLOSSY HOMALIA (*H. falcifolia*) with altogether different fruits. Its location is usually on rocks or on tree bases in the forest.

The CURLY MOSS (*Leptodon smithii*) is yet another British moss no less common in New Zealand where it is usually located on trees or rocks in the drier forested areas. In dry weather the tips of the branches are much inrolled, a feature rarely seen in other New

Zealand mosses. All of these latter mosses are related to the *Neckera* as also is the FAN MOSS (*Trachyloma planifolia*) which usually grows on the lower five or six feet of forest lianes or slender-stemmed shrubs and trees. The fronds are flat and stand out at right angles to the supporting stem. Commonly a silvery sheen may be noted on portions of the frond, or black 'propagula' near the upper margin.

Two mosses with horizontal stems projecting from tree trunk or tree-fern and horizontal or drooping, cylindrical, rarely branched, leafy fronds are the STOAT'S TAIL MOSS (*Cyrtopus setosus*) and the bronze-green *Cryptopodium bartramioides,* a monotypic genus confined to New Zealand. In both the narrow leaves surround and completely conceal the stems save near the base.

One of the moss genera, which is a characteristic feature of well-lighted tree trunks and to a smaller extent of rocks, is *Macromitrium* popularly known as MITRE MOSSES. These mosses form patches sometimes of considerable extent with horizontal creeping stems from which arise large numbers of short leafy branches usually terminating in an erect sporophyte, though such are rarely produced on at least two species. In general the setae are very short but *M. longipes* is so named because of the longer setae usually exceeding an inch. The similarity of habit of all species enables them to be recognized as mitre mosses, though it is rather more difficult to distinguish the individual species. The allied genera *Orthotrichum* and *Ulota* form smaller patches or tufts usually with sessile, strong-ribbed capsules.

Two species of *Lepyrodon, L. australis* with plicate (folded) leaves and *L. lagurus* with smooth leaves are frequent forest epiphytes, forming massive spongy cushions with a felt-like interior serving to absorb and retain

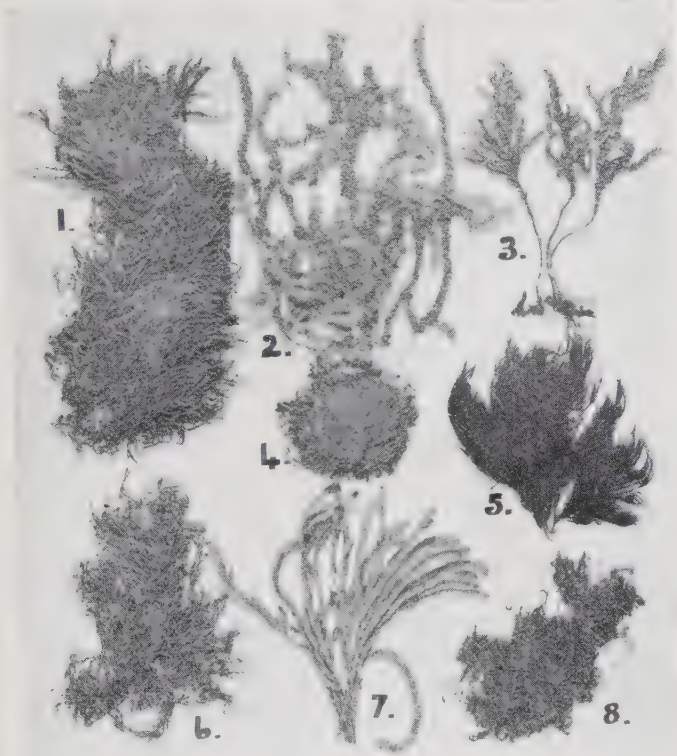


FIG. 17. New Zealand Mosses

1. *Eurhynchium austrinum*; 2. *Ptychomnion aciculare*; 3. *Trachyloma planifolium*; 4. *Bryum blandum*; 5. *Blindia immersa*; 6. *Macromitrium eucalyptorum*; 7. *Cladomnium ericoides*; 8. *Rhacopilum strumiferum*.

moisture. Two species of PINCUSHION MOSSES (*Leptostomum*) have the same habit but are distinguished by the very long setae and large capsules studded like large pins over the surface. These are plants of full light, whereas the Lepyrodons grow only on trees within the forest.

On the stems of forest trees few mosses are more common than the YELLOW-BELLY (*Hypnum cupressiforme* var. *chrysogaster*) with leaves beautifully curled, and a thread-like variety of *H. cupressiforme* which is usually found in the track of the run-off of rain water. This species is one of the most widely distributed and most variable mosses in the world. Well-lit trees and shrubs, especially in subalpine habitats, may be hosts for two species of SHIELD MOSS (*Dicnemon*) so named because only the capsule or a portion of it appears above the enclosing 'perichaetium'. They are alternatively termed COLLAR MOSSES.

Finally, mention must be made of a leafless moss (*Ephemeropsis*) which grows on the slender terminal twigs of shrubs on the forest margin from Taupo to the Otago Sounds. It is so tiny that the capsules are just visible to the unaided eye when held up to the light. Here the persistent protonema functions as a leafy stem. The only other local genus of leafless mosses is *Buxbaumia*—the gnome mosses—of which New Zealand has two species with unsymmetrical capsules flat above and rounded below.

Forest Mosses (c) Stream Mosses

Forest streams have very commonly one or more of some half-dozen aquatic or semi-aquatic mosses, chief of which are species of *Eriopus,* so named from the crest of hairs seen at the angle of the seta in at least one species—*E. cristatus*—the purpose of which

is not certainly known. Exceedingly common is the STREAM SPLIT MOSS (*Fissidens rigidulus*) the leaf of which clasps the stem after the same manner that the leaves of *Phormium* clasp one another at the base. Equally common or more so is a blackish-green moss with branched fronds known as *Thamnium pandum*.

In Stewart Island forest streams a very common moss, rare elsewhere, is that known as *Blindia immersa*. This has long green tresses trailing in the flowing water, sometimes exceeding a foot in length.

Rock Mosses

For convenience we shall note here both the true lithophytes which grow only on bare rock surfaces, and also such as are most commonly to be observed on rocks though not restricted thereto, and such as grow on a soil veneer overlying rocks, or in rock crevices where a little soil has collected.

First there are the nine or ten LANTERN MOSSES of subalpine and alpine rocks, two of which, however, descend to sea-level in Stewart Island. These constitute a division of the Moss Family distinct from all others in the fact that the capsule splits along four vertical lines to facilitate spore dispersal. The four valves may remain attached at base and tip or may roll back as in the hepatics. The species with the largest leaves and capsules is *Andreaea aquatica* which is, however, only an aquatic variety of *A. nitida*. *A. subulata* forms extensive reddish mats on the rocky sides of mountain streams but *A. nitida* var. *aquatica* is commonest on stones emergent from the stream itself. Much the commonest species with a world-wide distribution is *A. rupestris*, which forms tiny black tufts on alpine rocks on most mountains.

In similar stations we may often discover the

SOUTHERN ROCK MOSS (*Rhacocarpus humboldtii*). This forms carpets of considerable extent on the rocky walls bordering the Franz Josef Glacier, at Arthurs Pass, and in similar subalpine stations. The capsules are red in colour and globular in shape, while, as Dixon has pointed out, the red glossy hair points of the leaves form a very beautiful microscopic object, by which alone the moss can be identified. Probably the moss ascending highest on alpine rocks in New Zealand is *Rhacomitrium ptychophyllum*, a name which, being translated, means the moss with the tattered calyptra and folded or furrowed leaves. It is occasionally met with also in subalpine bogs, and like the Andreaeas, reaches sea-level in Stewart Island. 'The moss' is the name by which another member of this genus is best known on such mountains as Egmont or Ruapehu, a name more likely to be used than *Rhacomitrium lanuginosum* var. *pruinosum* by which the botanist designates it. This is the grey or whitish moss which forms conspicuous mounds and carpets on otherwise bare mountain sides. The long, hoary, spinulose hair points on the leaves are most attractive when viewed through a lens.

Of all the rock-frequenting mosses, however, *R. crispulum* is probably the commonest at all levels, and the most variable. All four New Zealand species of *Rhacomitrium* were observed by the author growing in the space of a square chain at the Homer Tunnel near Milford Sound.

The allied genus *Grimmia* has three very common members—*G. apocarpa, G. pulvinata,* and *G. trichophylla*—besides others of very restricted distribution. The first-named has the capsules partially concealed in the tips of the stems. It has a variety *rivularis* found only on rocks liable to frequent immersion by a running

FIG. 18. New Zealand Mosses

1. *Hypopterygium filiculæforme*; 2. *Mniodendron comosum*; 3. *Hypopterygium setosum*; 4. *Papillaria crocea*; 5. *Cyathophorum bulbosum*; 6. *Eucamptodon inflatus*.

stream in areas south of the Volcanic Plateau. The other two form small, rounded, furry cushions or buttons on rocks at all levels, and often in places where daily scorched by the summer sun, but where as a rule night fogs are frequent. *G. laevigata* is locally common throughout the South Island, especially in Central Otago. *G. inaequalis* is known only from Mt. Watkins in Otago, and *G. argentea* only from Castle Hill in Canterbury, but the other three are world-rangers.

Other rock-frequenting mosses of the lower levels are quite numerous, especially species of SCREW MOSS (*Tortula*), of *Orthotrichum,* and of THREAD MOSSES (*Bryum*). The CANDLE SNUFF MOSS (*Encalypta vulgaris*) and *Hedwigia ciliata*, a grey moss related to the *Rhacocarpus,* and, like it, bearing terminal globular, red capsules, are other mosses likely to be met on stones lying in open spaces.

The CONE MOSSES (*Conostomum*), two in number, may be recognised by the leaves which overlap tightly to form five prominent lateral ridges on every stem. They are subalpine mosses of rock and fell-field.

Mosses of Open Country

Here may be grouped all mosses that frequent lawns and pastures; clay soils or roadsides; swamps, bogs, and river courses; country hedgerows and city streets. Only a few of them can be mentioned here.

Some half-dozen species of BOG MOSS or SPHAGNUM, pale yellow or deep green, are distributed over the country wherever bogs and swamps exist. They take many forms but all have a family likeness whether short and robust, or lax and tenuous. They, like the lantern mosses, are distinguished from all other mosses as a distinct class by themselves. The habit of dying at the base and growing at the apex enables each branch in

time to become a separate plant. Accordingly, swamps and bogs are in time converted to dry land, for the acid conditions prevent decay of the dead vegetation, which accordingly forms peat. *Sphagnum*, some species of which can absorb 200 times their own dry weight of water, was much used in the two world wars as a dressing for wounds, for which purpose it is much superior to cotton wool.

In Westland the writer once collected specimens of the COMMON HAIR MOSS (*Polytrichum commune*) with stems six feet long growing in deep water holes by the railway line south of Hokitika. This must surely rank as a giant among mosses. Normally it is less than a foot tall.

The KAURI-SWAMP MOSS (*Eucamptodon inflatus*) when well grown is one of our most handsome mosses. Though found in the South Island, it is much more common in the northern part of the Auckland Province, especially on the poorer swampy soils of kauri country. It has never been found bearing capsules.

The golden *Thuidium furfurosum* is a most abundant moss in pastures, on dry sterile soils in the open, on moist forest tracks and in manuka scrub. Others of dry sterile soils or of pasture land include the ubiquitous *Ceratodon purpureus* with bright red upright setae and characteristic bent, furrowed capsules; the CORD MOSS (*Funaria hygrometrica*) with bright yellow setae and drooping pear-shaped capsules; and the pale *Brachythecium rutabulum*—all world-ranging species. Here too we find the THREE-RANK MOSS (*Triquetrella papillata*) with leaves in three rows, and small mosses belonging to the genera *Bryum*, *Acaulon*, *Astomum*, and *Pottia*.

Mosses of clay banks are numerous, but the BENT-FOOTS (*Campylopus*), the JUNIPER MOSS (*Polytrichum*

juniperinum), and the smaller but related *Pogonatum subulatum,* are the more common members where the soils are relatively dry, while the APPLE MOSSES (*Bartramia,* etc.) are typical on wet banks. One of these (*Breutelia pendula*) is specially common not only on wet banks but also in swamps. These derive the popular name from the green, spherical capsules of immature plants. When ripe the capsules are brown and furrowed.

Of almost five hundred native mosses, fully one-third are restricted to New Zealand. A third of the mosses are restricted to the Auckland Province and another third to the South Island. Six genera each of a single species are quite restricted to New Zealand. Very many are common to New Zealand, Australia, and Tasmania, and some are known only from South America and New Zealand; while over seventy are common to this country and to lands north of the Equator.

Hepatics or Liverworts

By reason of the existence over much of New Zealand of a warm moist (humid) climate the cryptogamic flora is particularly well represented by ferns, club mosses, mosses, liverworts, and fungi. In each group there are world-ranging species and species restricted to this Dominion, besides others shared with Australia, Tasmania, or South America.

The popular name, liverwort, applied to the larger hepatics is an old folk-name. Because the plants both in general appearance and shape were deemed to be in miniature a picture of the human liver, by the old 'doctrine of Signatures', they were deemed to be a suitable medicine for afflictions of that organ. When referring to the liverworts Culpeper describes them as 'a singular good herb for all diseases of the liver, both

to cool and to cleanse it, and helpeth the inflammation in any part, and the yellow jaundice likewise'. Further it is 'an excellent remedy for such whose livers are corrupted by surfeits, which cause their bodies to break out, for it fortifieth the liver exceedingly and makes it impregnable'. It had to be 'bruised and boiled in small beer and drank' but in what quantities, as Hutchinson in his *Popular Botany* points out, was left to individual choice.

There are three principal divisions of these plants, the first of which, *Marchantia,* is a typical example, having two internal layers of tissue, the upper compact and connected to the surface by numerous minute openings or pores: the lower of thin-walled larger cells. This group comprises a small number of genera (8 or 9) wholly without leaves. The second division contains numerous genera, mainly leafy, in which there is no zonation of tissue and no external pores. The members of the third group are best distinguished by the very long two-valved capsule arising from a swollen base and surrounded near the base by a sheathing pocket.

There is scarcely any conceivable station in the humid interior of the forest but supports a number of these humble plants. Logs, stones, stems, tree trunks, fern caudices, leaves, stream banks, and the forest floor itself, all have their characteristic species not a few of which are exquisitely beautiful. Most species are small and often insignificant as individuals, yet many grow in colonies of considerable extent or build mounds or cushions of quite large size.

Frondose Hepatics

'The branches of many living trees, even the topmost of the tallest, including branchlets that are dead, are often clothed with them; the steep sides of streams

and mouths of caves abound in species; and even isolated stones and boulders, and dry hardened logs denuded of their bark and exposed to the hot rays of the burning meridian sun, possess them, exhibiting most astonishing proofs of their endurance and long vitality; even dry black and charred logs, extra heated in the sun, are often thickly clothed with a small red species, bearing fruit, too, presenting an uncommon appearance after rains.

'Many of them are very beautiful, being most exquisitely and symmetrically formed and adorned; each species, however minute, possessing the greatest regularity in shape and size of leaves, in their delicate fringes, and their mathematically-formed cells, etc., and this in its most delicate and microscopical distinctions.

'Here is to be seen the perfection of elegance and beauty in nature's humblest productions. Permit me more particularly to call your attention to the specialities of some of our genera of this order—e.g., in form, so intricately and finely compound, almost bewildering, yet regular—*Trichocolea;* and on the other hand so very simple—*Symphyogyna;* in size, *Plagiochila,* some of which are large, dendroid, and tree-like, branched and nearly one foot high, resembling small shrubs; while others of this same genus are very minute; in extreme fineness and delicacy of structure—*Zoopsis* and *Psiloclada;* in remarkable close regularity, shape and position of their imbricated leaves—*Isotachis, Madotheca, Mastigobryum*: in their charming rich and varied colours (on the one plant), golden, orange, purple, emerald green, etc.—*Polyotus*: in elegance and richness of superb cutting and fringing—*Gottschea, Chiloscyphus*: and generally, in their minute cells, their structure, shape, regularity, and mathematical correctness; in their endurance, retaining life though daily heated

and scorched, crisped and dried up by the summer's sun; in the excessive minuteness and regular form of their microscopical spores; in the highly curious manner of the distribution of their spores when ripe, which is done by coiled and double-spiral elaters, or springs.' In these well-chosen words does Bishop Colenso write of the New Zealand hepatics in volume XXIV of the *Transactions of the New Zealand Institute.*

In this group we include all the leafless hepatics where the thallus performs the functions of the leaf. The largest of these is *Monoclea forsteri,* a monotypic genus with undifferentiated internal tissue but forming large, highly-polished green thalli on rocks emergent from forest streams or on the muddy forest floor nearby, to which they are anchored by a forest of pale rhizoids. This hepatic rarely fruits, but when it does it forms a short white stalk terminated by a brown capsule that bursts along one margin to liberate the spores. The base of the stalk is enclosed in a tall sheathing calyptra.

To a second group of frondose lichens belong *Marchantia* and the closely related *Lunularia, Reboulia hemisphaerica, Asterella, Plagiochasma,* and *Targionia,* all with lobed thalli but with entirely different fruiting organs.

Among the members of the former group there are three very similar plants easily confused when not in fruit, namely *Symphyogyna, Hymenophytum,* and *Pallavicinia.* These form large colonies on the banks of forest streams and on damp, shaded banks elsewhere. *H. flabellatum* commonly grows on stones on the forest floor as well as on wet banks. This is easily recognised, for the frond consists of an erect stalk supporting a completely circular umbrella placed parallel to the soil and about an inch in diameter. *S. hymenophyllum* is a

common fan-shaped associate; while several strap-shaped species (*S. obovata, S. subsimplex,* etc.) are as common on the stems of tree-ferns as on the ground.

Species of *Metzgeria* have thin narrow fronds that repeatedly fork into two equal segments. In two species the fronds or portions of them commonly turn bright blue. These plants grow on trees, shrubs, and tree-ferns. *Riccardia* has numerous species on logs, earth, rocks in the stream-bed, stream banks, and occasionally on trees. *R. eriocaula* is such an epiphyte, but one of the finest species is *R. colensoi* with pectinate (comb-like) fronds up to two inches long. A common brittle species in wet localities is probably *R. pinguis,* but the genus requires revision, as the identity of some plants is not at all certain.

The commonest *Marchantia* is *M. berteroana,* a plant especially common on peat-bogs and peaty soils generally. Each lobe has a central midrib and numerous rhizomes on the lower surface, while fruiting plants have two types of erect 'carpocephala' with stellate umbrellas, the lobes of the male structure being wide and of the female carpocephalum narrow. The pores are here very tiny as in *M. nitida;* but in *M. macrospora* they are quite conspicuous to the unaided eye. Gemmae are produced by each in circular cups which are capable of reproducing the plant by vegetative means. In *Lunularia* the gemmae cups are crescent-shaped.

Foliose Hepatics

By far the leafy hepatics, sometimes known as Scale-mosses and Crystalworts, outnumber the frondose liverworts; but in a small hand-book it is not possible to refer to more than a few of the commoner, larger, or

more striking members. The following genera are represented by more than twenty species—*Plagiochila, Frullania, Lepidozia, Chiloscyphus,* and *Lophocolea*—while *Schistochila* with more than a dozen species includes a number of large and handsome hepatics, *S. appendiculata* and *S. nobilis* being two of the most striking with stems up to six inches long by half an inch wide. These and most other species are ground-dwellers in the valley bottoms of dank forest; but the

W. Martin, del.

FIG. 19. New Zealand Hepatics

1. *Chiloscyphus billardieri*; 2. *Hymenophytum flabellatum*; 3. *Tylimanthus saccatus*; 4. *Plagiochila gigantea*; 5. *Hymenophytum phyllanthus*; 6. *Lepicolea scolopendra*; 7. *Schistochila pinnatifida*; 8. *Schistochila nobilis*; 9. *Chiloscyphus sinuosus*, 10. *Mastigobryum novæ-zelandiæ*; 11. *Symphyogyna hymenophyllum.*

species known as *S. tuloides* is usually an epiphyte with short, brown stems. *S. ciliata,* as the name suggests, has the leaves fringed with hairs. It is almost white in colour and grows both on the ground and on trees.

Included in *Plagiochila* are numerous cushion-forming or mat-forming epiphytes as well as others, some quite large, which are restricted to the forest floor or to stream beds. Thus in Stewart Island *P. ramosissima* and *P. gigantea* are sometimes found forming mounds a yard through and almost as high, though, of course, this is exceptional. On the margins of forest streams *P. stephensoniana* may have fronds up to a foot tall and wide in proportion. The leaves of mosses are never indented though they may have marginal teeth. Hepatics on the other hand frequently have lobed or much indented leaves with large spinous teeth. Those of mosses are usually symmetrical, but in hepatics the leaves are very commonly of a very irregular shape, and this is well represented in the species of *Plagiochila* for the leaves are both unsymmetrical and fringed with marginal spines, especially on the upper margin. Then again, numerous mosses have leaves with a well developed midrib, a feature never found in the leafy hepatics.

The Frullanias are slender mat-forming hepatics commonly dark brown in colour and growing on rocks, tree trunks, or on shrubs, manuka especially. No station seems too bleak or exposed for these hardy hepatics. Pendulous hepatics are not numerous, one of the commoner being *Lepicolea scolopendra,* especially common in the forests of West Otago. Others include *Lepidozia pendulina, L. setigera, Mastigophora flagellifera,* and *Porella stangeri.* This last is a very common hepatic with pinnately branched stems up to a foot long, creeping or pendulous, and forming loose

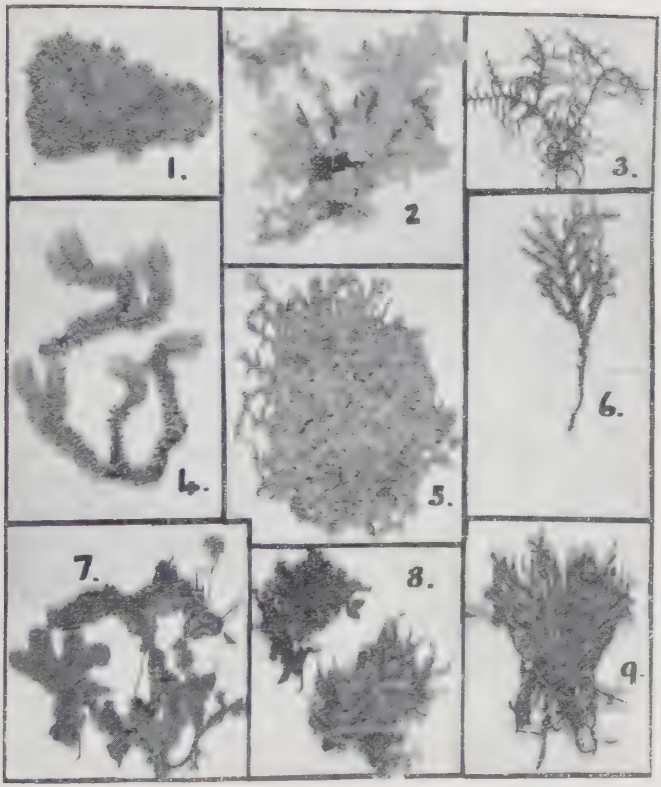


FIG. 20. New Zealand Hepatics

1. *Metzgeria hamata*; 2. *Trichocolea mollissima*; 3. *Sendtnera flagellifera*; 4. *Schistochila nobilis*; 5. *Trichocolea lanata*; 6. *Plagiochila stephensoniana*; 7. *Marchantia berteroana*; 8. *Hymenophytum phyllanthus*; 9. *Chandonanthus squarrosus*.

mats. The leaves are closely overlapped, yellowish-green, convex, and entire.

On smooth-barked trees another common and pretty plant (*Lepidolaena Taylori*) found on upright trunks rather than on sloping branches as in the case of the Porella, looks rather like filigree work; and when, as sometimes happens, it acquires a reddish tinge it becomes specially attractive.

Ground-dwellers include numerous species of *Bazzania, Chiloscyphus, Lepidozia,* and *Lophocolea.* One of the commonest on decaying wood is *Chiloscyphus billardieri,* a pale, diaphanous, creeping hepatic. In the spray of a waterfall in shady forest one is almost sure to observe *Lepidozia spinosissima* with long slender stems and numerous branches finer than cotton thread, the minute leaves ending in four slender filaments.

Two common brown hepatics each the sole representative of its genus are *Chandonanthus squarrosus* and *Cuspidatula monodon,* both somewhat similar in appearance, with, as a rule, unbranched leafy stems and sharp-pointed leaves. The so-called SPONGE-MOSSES are pale grey-green hepatics of the genus *Trichocolea,* with branches that look like sponge or flannel, especially when viewed through a lens. The commonest species (*T. mollissima*) with bi-pinnate branches is found in the Auckland Islands as well as in New Zealand, but *T. lanata* with pinnate branches is restricted to this Dominion. In both the leaves are so much dissected and interwoven that they do not look like leaves at all. They are both beautiful plants of the forest floor, logs, and tree bases, luxuriating in the wettest climates.

Not less beautiful, and, in fact, one of the most attractive of all the indigenous hepatics, is *Isotachis lyallii* which in South Westland frequently covers large areas of roadside banks with its pinkish purple foliage.

It is then so striking that even the most casual traveller cannot fail to notice and admire it.

The third group comprises a small number of hepatics with green thalli several cells thick, and erect sporophytes of two valves dehiscing (opening) downwards. These belong to four genera of which *Anthoceros* is the best known.

In conclusion it may be noted that hepatics prefer wetter climates than do the mosses, so that the relative proportions of these two types of bryophyte depend on the annual rainfall, hepatics being especially numerous in the West Coast Sounds and in the south of Stewart Island both in number of species and of individuals, as well as reaching their finest development there.

CHAPTER V

CLUB-MOSSES AND OTHER FERN ALLIES

THE SMALLEST OF FOUR MAJOR DIVISIONS of living plants is that known as the *Pteridophyta,* to which belong the ferns, club-mosses, Selaginellas, horsetails, and quillworts besides a small group of 'living fossils' known to botanists as the *Psilotales,* but without popular title. The ferns will be considered separately, and as there are no indigenous members of the selaginellas or horsetails, these will not concern us here further than to mention that many millions of years ago, before the advent of flowering plants, horsetails and lycopods were two of the dominant types of vegetation, with numerous arborescent members many over one hundred feet tall. These plants, however, have had their day, and only a few diminutive remnants persist, widely dispersed as one would expect from their ancient lineage. In fact, only two of our eleven species of lycopod are restricted to this Dominion. Club-mosses and mosses are quite unrelated plants.

Four New Zealand species are the largest lycopods now in existence, including *L. volubile* and *L. cernuum,* both under ideal conditions producing stems fifteen feet or more long. The first named—the OWL'S-FOOT or CLIMBING CLUB-MOSS—is found abundantly throughout New Zealand. Like all other lycopods, it commences as a spore which gives rise to a small tuberous 'gametophyte'. Fertilization is followed by the formation of the plant known as the club-moss which in turn reproduces the spores. The young plant has leaves

all round the stem, but in older plants the leaves are present in two lateral rows as in *L. scariosum*. Some leaves have hooked tips probably aiding the plant to climb over any nearby vegetation. The climbing club-moss is more accurately a scrambler, being most common in manuka scrub or on forest margins. Near Pelorus Bridge on the highway from Blenheim to Nelson it occurs in quantity in the forest clearings, forming thickets of entwined stems and branches that terminate in large clusters of fertile spore-producing spikes.

L. cernuum is confined to the Auckland Province being specially abundant on the clay gumlands of North Auckland, but nowhere more robust and luxuriant than on the heated soils near boiling springs and fumaroles in the Rotorua area. Here the rhizome progresses by a series of arching loops which root whenever they come into contact with the soil. Lateral branches are numerous, as well as erect fertile branches bearing many short spore-producing cones.

Two other lycopods confined to Auckland include the rare and almost extinct *L. drummondi,* formerly known from a single sphagnum swamp near Kaitaia, and the BOG CLUB-MOSS (*L. laterale*) which is also common on Chatham Island. From a much-branched underground rhizome, short erect stems arise at intervals usually reddish in colour in the open but longer and green when in the shade of shrubs. The most distinctive feature is the lateral position of the fertile spikes.

The TREE CLUB-MOSS (*L. densum*) is to be seen in Nelson and in the north of the North Island. It has a very distinct bushy appearance with numerous erect branching stems originating at intervals along a stout subterranean rhizome, each branchlet closely resembling the twigs of a rimu tree. The 'cones' are produced singly on the tips of the stems.

W. Martin, photo

FIG. 21. New Zealand Club-mosses (*Lycopodium volubile* and *L. densum*

Two species from the subalpine and montane areas of both main islands and located either in grassland or in shrubberies are *L. scariosum* and *L. fastigiatum*. The stems of the former rarely exceed five feet and give off short horizontal rooting branches with two-ranked leaves, as in the climbing club-moss, but differing in that at its base each leaf is decurrent along the stem. The 'cones' are produced singly on the terminal branchlets whereas in *L. fastigiatum* several fertile spikes terminate the stems. The leaves in this and all other species found in New Zealand save the two with two-ranked leaves, are developed all round the stem. Actually scale leaves are also present on the sterile branches of *L. volubile* and *L. scariosum*.

A bog-frequenting club-moss commonest in the South Island and Stewart Island forms extensive mats of interlacing plants each under a foot long and with both underground and aerial branches, especially on the West Coast of the South Island where it grows not only on sphagnum swamps but on peaty forest soils. This endemic lycopod (*L. ramulosum*) produces both lateral and terminal spikes.

L. billardieri is an epiphytic species commonly observed on forest trees where its pendulous branches are terminated by a cluster of narrow branching spikes. *L. varium* resembles it, but has a more erect habit and grows not only on trees but on rocks or on soils. A short stubby rock-dweller known as *L. australianum* has no distinct fertile spikes, the sterile and the fertile portions of the stem being quite similar.

A remarkable little plant only an inch or two tall and related to the club-mosses, known as *Phylloglossum drummondi*, is known only from North Auckland and from the south coast of Australia. This has a tuberous root from which arise a number of linear leaves and a

short club-headed fertile spike. A new tuber is formed annually before the aerial portions of the plant die and disappear in the hot summer months, and from this a new set of leaves is produced in late autumn. It is confined to peaty swamps, grassland, and clay gumland soils north from Auckland city.

Quillworts (*Isoetes*) are represented in New Zealand by two aquatic species, both endemic and located as a rule in upland lakes and tarns in both islands. Strictly, they belong to a distinct family with features both of ferns and of lycopods, yet in appearance resembling neither. They remain permanently submerged and consist of a short tuberous stem from which arise a large number of linear leaves usually exceeding thirty in *I. alpinus* but rarely reaching thirty in *I. kirkii*. The spore cases are located at the bases of the leaves and contain two types of spores—large female macrospores and tiny male microspores.

The *Psilotales* have two New Zealand representatives though neither is restricted to this country. These plants are obvious remnants of a type of primitive plant once abundant but now well-nigh extinct, corresponding in the vegetable world to the tuatara among animals. Both are rootless plants wholly or partially saprophytic and living in humus on trees, tree-ferns, or in rock crevices. The first is *Psilotum triquetrum*, a twiggy little plant 12 to 18 inches high, with fluted stems and scale-like leaves, and provided with three-chambered capsules placed at close intervals along the ribs of the stems. In New Zealand it may still be gathered close to the wharf on Rangitoto Island, on Mayor Island, and near the summit of Mt. Maunganui at Tauranga, but rather more commonly on the heated soils of the thermal area. It does not occur elsewhere than in the Auckland province.

Much more common and widespread is the second

plant (*Tmesipteris tannensis*). In New Zealand it occurs in quantity on Stewart Island but in more restricted abundance elsewhere. This 'fossil' plant has a creeping, much branched rhizome wholly devoid of roots which grows most commonly on tree trunks and tree-ferns but not uncommonly on the ground also or on logs. A fungus associated with the rhizome probably aids it in securing nutriment from the humus material. The pendent fronds vary from one inch to more than two feet in length, though ground-dwellers are commonly sub-erect and very short-stemmed. The leaves, triangular in shape, are attached to the stem by a wide base so that the leafy stems bear a strong resemblance to the English butcher's broom. The spore capsules are two-chambered and numerous on the terminal portion of the frond, each resting on a sort of double leaf. Outside of New Zealand it ranges north to the Philippine Islands, unless, as seems possible, two species are involved.

CHAPTER VI

THE FERNS

THE FERN IS SO STRIKING a feature of the New Zealand landscape that its frond has very appropriately been chosen as the coveted badge to be worn by all who achieve representative honours, be they bowlers or cricketers, Anzacs or All Blacks. A wide range of latitude, a genial climate, and an abundance of rain combine to make the New Zealand rain-forest a paradise for ferns, surpassed only in the tropics. It is to numbers of individuals, however, rather than of species that this wealth is due, for all told there are scarcely one hundred and fifty different species on the mainland, yet between one species and another there is often an endless number of hybrid or intermediate forms.

Now the fern is our most highly organized representative of the spore-producing plants or cryptogams, as they are often termed, to distinguish them from that other numerous group—the seed-bearing or flowering plants known as phanerogams.

Ferns have a characteristic structure and life history varying only in detail among the the different species. The leaf or frond of the fern is distinguished from true foliage leaves by the development on its back or margins of sori—clusters of sporangia or spore-cases, each containing its quota of spores. These sori may be arranged in round dots or in straight or crescentic lines, and may further, when immature, be protected by a covering flap or indusium, the presence or absence of which serves in part to distinguish one fern from

another. Indeed, the various genera into which ferns are grouped are determined mainly by the position, shape, and character of the sorus, its covering, and its contents.

A study of the various ferns quickly shows that these fronds may grow together in tufts or they may originate at intervals along a creeping stem or rhizome, or yet again they may, as in the tree-ferns, form a crown at the top of a vertical stem or caudex. Each of the main lobes of the frond is a pinna, and the pinnae grow on either side of the rachis or midrib, which is continued as the stipes or stalk to join the rhizome.

It is not a difficult matter to get to know all the New Zealand ferns. Some of the largest and most conspicuous groups are those commonly known as filmy ferns, spleenworts, polypodies, and hard-ferns. The brackens, shield ferns, umbrella ferns, and tree-ferns likewise form a fair proportion of the total.

It is interesting to note that while most ferns luxuriate in moist, shady stations, some of our most interesting ferns, though far from being the most beautiful, are to be sought only on sun-baked rock or in dry clay or shingly soils.

Filmy Ferns and **Bristle Ferns**

Ferns belonging to the two groups known as FILMY FERNS and BRISTLE FERNS number about a fifth of the New Zealand fern flora, and fully a third of those found in Stewart Island. Formerly all the filmies were classed as species of *Hymenophyllum* and the bristle ferns as *Trichomanes;* but recent research has caused their separation into a dozen or more genera with the result that half the filmy ferns now belong to the genus *Mecodium,* ten of which are restricted to New Zealand.

Amongst the species of this genus are included the

W. Martin, photo

FIG. 22. Filmy Ferns and Bristle Ferns

largest and the most handsome of all the filmy ferns, pride of place going to *M. pulcherrimum,* an aptly named species and the only one with a tufted habit of growth. It is chiefly a fern of upland forests where it grows on mossy tree bases or boulders, or on the rocky but moss-clad walls of subalpine forest ravines. From the moss the roots take in water, so enabling the fern to withstand desiccation when the air is dry; for filmy ferns obtain most of their water requirements directly from the moist air through the surface of the fronds. These in well-grown plants may exceed a yard in length but the normal size is less than half of this.

Next in size come two species with similar climatic requirements which are therefore commonly associated either on logs or on the horizontal boughs of lowland forest trees. These have creeping rhizomes from which erect or pendulous fronds arise at close intervals. The first of these is *M. dilatatum,* a bright green plant with the segments of the frond wider than in any other species. The other (*M. scabrum*) has dark green fronds equally large but much narrower, while the stipes of the frond is clothed with short, reddish, jointed hairs. Both have portions of their fronds two or three cells thick, whereas most filmy ferns have them but one cell in thickness.

The largest of the ground-dwellers and the commonest are *M. demissum* and *Meringium bivalve,* both of which form extensive colonies that may also cover the lower tree trunks. The latter is uncommon at the lower levels but ranges as far as Australia, while the former is restricted to New Zealand but grows at all levels. Both are specially common in subalpine beech forests. Both have triangular-shaped fronds, those of *M. bivalve* being rather more finely dissected with the lowest pinnae the longest.

Probably the most abundant filmy ferns are three species commonly associated. The first is the PHOTOGRAPHIC FERN (*M. sanguinolentum*) so named because when dried and pressed it leaves a brown stain on the paper accurately depicting its own form, even though light is not an agent in the process. The second species is *M. villosum* and the third *Meringium multifidum* which ranges from sea level to almost four thousand feet altitude, usually on moss-covered tree trunks but also on mossy rocks and boulders. At the higher levels *M. villosum* is the usual associate, *M. sanguinolentum* replacing it in the lowland forests. Though desiccation causes these mosses to curl up somewhat they quickly revive when moist conditions return.

Of the tiny members, that known as *Craspedophyllum armstrongii* is probably the commonest; but, being as a rule a plant of the forest tree tops, it is not often observed. *Mecodium australe,* a plant of medium size, is easily distinguished by the crisped wing bordering the stipes.

The only fern that is almost wholly restricted to the caudices of tree-ferns is the one usually known as the COMMON BRISTLE FERN (*Polyphlebium venosum*) with fronds that are slender, narrow, and strap-shaped. While not thus restricted, the much larger, handsome, bronze-coloured RUSTY FERN (*Sphaerocionium ferrugineum*) commonly drapes the caudex of a tree-fern with its numerous, overlapping, pendulous fronds. This, like the smaller subalpine *Mecodium rufescens,* has numerous stellate hairs on the surface and margins of the fronds, as has the peculiar brownish KAWAKA FERN (*Apteropteris malingii*) which is usually the only filmy to be found on the bark of the native cedar or kawaka, where alone it grows in most forests, though an occasional plant or colony has been observed on totara

W. Martin, photo

FIG. 23. The Rusty Fern (*Sphaeriostomum ferrugineum*) on trunk of a Kamahi tree in forest, Stewart Island

and even on granite boulders on Mt. Hope in Nelson. Wherever the kawaka is found, there kawaka fern will also be found; but it shows a preference for dead trees or fallen logs to the living plant. Someone has drawn attention to a common habit of the filiform rhizome to follow a crack in the bark and thus to climb to a considerable height. Dr. Holloway states that this fern occurs also in Tasmania, while Miss Crookes lists it as endemic to New Zealand.

A majority of the bristle ferns are to be looked for on or near the banks of forest streams where, with two exceptions, they form rather compact tufts. The Anomalous KIDNEY FERN has features linking it both with the filmy ferns and the bristle ferns, neither of which it resembles, however, in external appearance. The botanical name *Cardiomanes reniforme* draws attention to the kidney-shaped lamina of the frond, which gives the plant its unusual, unfernlike appearance. Colonies of wide extent often cover the ground, logs, or tree bases. The blade is often two to five cells thick, and fertile fronds have a marginal fringe of projecting sori. As it is normally a plant of rain-forest its presence on sunbaked scoria boulders on Rangitoto Island is worthy of note.

Spleenworts

The spleenworts (*Asplenium*) with a dozen or more New Zealand species may be recognised by the linear sori margining the inner margins of the veins on the lower side of the frond, usually at an angle of approximately 45° to the main stems of the pinnae. Though some of the species are very variable in form, partly because of inherent plasticity and partly because of the occurrence of numerous hybrids, a majority are easy to identify.

The COASTAL SPLEENWORT (*A. obtusatum*) is a dark green species with thick leathery leaves to be seen on maritime rocks from one end of New Zealand to the other. The forest equivalent is the SHINING SPLEENWORT (*A. lucidum*) which has tall fronds with shining surfaces, sometimes three feet in height. On one occasion the author exhibited fronds from specimens found growing near Akaroa which exceeded seven feet in length. The HEN AND CHICKEN FERN (*A. bulbiferum*) is a ubiquitous species in New Zealand forests which, like the previous species, is a terrestrial plant but normally prefers a moister station. Under humid conditions, small plants may be observed growing from near the tips of the pinnae, whence the popular name. Yet another common ground-dweller in the lighter and drier forests is HOOKER'S SPLEENWORT or ROCKLAX (*A. hookerianum*), a dwarf member with open lax fronds and widely spaced pinnules. The TRAILING or RAT-TAIL SPLEENWORT (*A. flabellifolium*), also a ground-dweller as a rule, has short wedge-shaped pinnae arranged evenly along a long filiform stem save towards the tip which is commonly proliferous. Indeed, by a repetition of this process, seven generations of fronds have been observed growing on one continuous prostrate stem.

Of the epiphytic species, the commonest member is the DROOPING SPLEENWORT (*A. flaccidum*) with long narrow pinnae, which hangs its pendulous fronds from horizontal stems or from the trunks of tree-ferns. The sori often appear to be marginal on the upper edges of the pinnules. This fern ranges as far as South Africa and the Hawaiian Islands. Though it takes many forms it is usually easy to recognise. A larger epiphytic species (*A. falcatum*) commonest on sloping tree trunks or on tree-ferns is found throughout New Zealand in low-

land forests as well as in Australia, Polynesia, and elsewhere. The upper notched margin is always longer than the lower, but the base of each pinna is not notched at all. Fronds may measure anything up to two feet or more.

Polypodies

All local ferns in this group were formerly regarded as species of *Polypodium,* but today it is agreed that five genera are involved with ten species in all. These have sori in the form of round buttons or beads, more rarely oblong, without any covering scale. The fronds are usually thick or leathery.

One of the commonest representatives is the COMMON POLYPODY or BUTTON FERN (*Phymatodes diversifolium*). This has branching fleshy rhizomes a quarter of an inch thick which creep over the earth, logs, rocks, or tree trunks, and from which numerous leathery fronds arise which may be simple and strap-shaped, or strongly lobed, or even pinnate. The numerous sori usually form two rows midway between the margin and the midrib. Very similar to this in appearance but with narrower and longer lobes is *P. novae-zealandiae*, a species restricted to the centre of the North Island where it grows on trees and logs. The third member of this genus is *P. scandens* with thin, narrow fronds and irregular marginal lobes. The sori are dot-like and submarginal. This fern ranges the two main islands but is rare south of Westland.

Several small epiphytic polypodies, usually with simple unbranched fronds, often under an inch long but commonly several inches in length, belong to the genus *Grammitis*. These have linear rather than globular sori on either side of the midrib. A somewhat larger but closely related polypody has the name *Ctenopteris*

heterophylla. This is distinguished by the possession of numerous narrow pinnae strongly serrated on both margins. Normally the fronds are five or six inches long and grow from mossy tree trunks or on logs in forests at all elevations. The last calling for attention is a creeping fern, with small sterile fronds shaped like the lens of a pair of spectacles and longer, strap-shaped, fertile fronds (*Pyrrosia serpens*), which grows on exposed tree trunks, on rocks, on roots, and more rarely on the ground. The sori are often so numerous as to completely cover the under-surface of the fertile fronds which appear brown in consequence.

Hardferns

Those ferns having the generic name *Blechnum* are popularly known as hardferns by which is really meant hardy ferns, as indeed most species are. All are characterized by the possession of both sterile and fertile fronds, the latter invariably narrower than the former.

Two fairly common hardferns restricted to coastal banks and cliffs are BANKS'S HARDFERN (*B. banksii*) which ranges throughout New Zealand and *B. durum* which is not found north of Banks Peninsula. Much the most abundant species, however, is *B. procerum* known as the COMMON HARDFERN or KIO-KIO. This is a composite species with numerous forms ranging from sea level to over four thousand feet altitude and equally at home in the forest, on roadside banks, on open hillsides, in manuka thickets, or on the banks of streams. Whether more than one species is involved requires examination. Some forest forms have upright fronds six feet to ten feet tall, whereas hillside plants may be under one foot. In regions of high rainfall it may drape large areas of roadside banks with its numerous drooping and overlapping fronds. Young fronds on open hillsides may be tinted red, as in the next species.

Rather similar to this is a common roadside fern (*B. vulcanicum*) but distinguished by the lowest pair of pinnae being invariably deflexed. This fern is probably most abundant in subalpine stations above the bushline or in dry open forest. It has been referred to as the TRIANGULAR HARDFERN.

Of forest-frequenting species none is more common than the CROWN FERN or SWORD FERN (*B. discolor*), colonies of which often cover the forest floor as far as the eye can see. This results in part from the underground rhizomes which link and initiate many individual plants. The numerous fronds, three to four feet long, slope upwards and outwards from a short caudex, and have a white or reddish undersurface which alone will distinguish it. This is a plant of moist forests at all levels.

Beside forest streams, especially near their point of emergence from the bush, two abundant species are the CREEK HARDFERN (*B. fluviatile*) and the LANCE FERN (*B. lanceolatum*) the former with oval sterile pinnae and downward curved fertile lobes, whereas the other has lanceolate fronds with narrow lobes, those of the fertile plants curving upwards. This fern is also met with in Tasmania.

In very wet shady places especially where water is trickling or flowing the massive dull-green fronds of PATERSON'S HARDFERN (*B. colensoi*) may be looked for. Smaller strap-shaped fronds are sometimes present but usually the sterile fronds have numerous wide lateral lobes, while the fertile fronds have long narrow lobes up to six inches in length.

A small species with narrow, linear fronds about six inches high is common within the bush margin and on open hillsides. This fern (*B. penna-marina*) occurs at all levels but is much more plentiful at subalpine levels

whence the old name *B. alpina* and the popular name of ALPINE HARDFERN. There are two anomalous species —the CLIMBING HARDFERN (*B. filiforme*) and the MINIATURE TREE-FERN (*B. fraseri*)—absent from areas south of Nelson, which must be noted.

The climbing hardfern commences life on the ground and sends out many rhizomes with numerous fronds rarely longer than three or four inches. Should a rhizome reach a tree trunk, however, it thickens and commences to climb, giving off fronds of a totally different form, and commonly over two feet long. It may ascend the trunk for twenty to thirty feet; but six to ten feet from the ground fertile fronds equally distinct in form and appearance are produced, with very long narrow pinnae. FRASER'S HARDFERN is equally remarkable because when conditions are congenial as in the northern kauri forests, it sends up a slender caudex little more than an inch thick and from one to three feet tall bearing a crown of leafy fronds, fertile and barren being intermingled and very similar in shape and size. It is abundant in Auckland but absent from the rest of the North Island, reappearing near Collingwood in the South Island.

Tree-ferns

It has hitherto been customary to apportion our nine tree-ferns to four genera, viz. *Cyathea, Hemitelia, Alsophila,* and *Dicksonia* but it has been shown that the first three cannot be regarded as natural units. Today, all indigenous tree-ferns are classified in the two genera *Cyathea* and *Dicksonia.*

These tropical ferns peter out as we travel south, only four reaching Stewart Island, and only one (*C. smithii*) ranging as far south as Auckland Island.

There are three species of *Dicksonia, D. squarrosa,*

W. Martin, photo

FIG. 24.—Grove of Tree-ferns, Coromandel Peninsula.

known as the WHEKI or SLENDER TREE-FERN being much the most abundant. It is customary to find this tree-fern in groves all linked by subterranean stems. It is readily recognised by the slender caudex being surrounded by the short black stipes of the dead fronds. It is a hardy species long persisting in the open after the bush trees have been felled. The second species known as the PUNUI or WHEKI-PONGA (*D. fibrosa*) has fronds as harsh as those of the wheki, but the trunk or caudex is a foot or more thick and surrounded by aerial roots, while the younger fronds commonly form an upper crown with the older fronds forming a separate lower whorl. This fern can likewise persist in the open for many years after the felling of the bush. The third member is a smaller fern which, though ranging to Westland, forms a trunk only in the Auckland peninsula. The name WOOLLY TREE-FERN as well as the botanical name *D. lanata* is derived from the woolly covering of the bases and ribs of the young fronds.

Besides the wheki-ponga, two other tree-ferns have a thick, fibrous caudex. These are the PONGA or SILVER TREE-FERN (*Cyathea dealbata*) and the SOUTHERN TREE-FERN (*C. smithii*), the former with a silvery undersurface to the fronds, and the latter with soft, yellowish-green fronds. The silver tree-fern often has small projecting pieces of the stipes of dead fronds in its upper parts as a further distinction. The old-time Maori used the upturned fronds to mark forest tracks to be traversed at night.

The giant MAMAKU or BLACK TREE-FERN (*C. medullaris*) holds pride of place both for its stature and the spread of its massive fronds. A height of fifty feet and more and a spread of forty feet in the leafy crown are not unknown. Of course these are much in excess of normal dimensions. The mamaku is recognised at

once by the prominent hexagonal scars on the trunk and by the black stems of the fronds.

The PROSTRATE TREE-FERN or GROVE FERN (*C. colensoi*) is normally a subalpine fern with short fronds rarely exceeding four feet in length, and bright yellowish-green in colour, rising from a trunk (caudex) that lies prone on the ground. It does not occur in the northern half of the North Island. Several other ferns occasionally form a short caudex but would never be classed as tree-ferns.

The Maoris formerly baked the mucilaginous pith of the mamaku as an article of diet and strewed the fronds of the ponga or silver tree-fern on the floors of their whares; while rat-proof buildings were built of the split stems of the wheki-ponga, as were protective palisades surrounding some of their pas.

Brackens

The common bracken of hillsides and shrublands is *Pteridium esculentum,* so named because the rhizomes of selected strains provided an important food for the ancient Maori. It is regarded by farmers as one of the worst weeds, yet in nature, it is the first stage of a succession which leads to the re-establishment of forest. The WATER FERN (*Histiopteris incisa*) is a common fern of swampy patches on the bush margin or on heath lands with abundant rainfall. In the warm humid conditions bordering hot pools in the thermal area, the fronds may attain the remarkable height of twelve feet. Even the common bracken, however, under favourable conditions may be as tall.

The SILVER BRACKEN or LACE FERN, also known in parts of Westland as the pig fern (*Paesia scaberula*) is a slender and graceful plant with very finely divided foliage rarely exceeding a couple of feet in height. It

is a common pioneer on freshly exposed soils such as are provided by recent slips, road banks, or railway cuttings but never in heavy shade, and can be a really noxious weed on farm lands.

Probably our most attractive forest brackens are *Pteris macilenta* and *P. tremula,* two species rather similar in size and habit with bright green foliage, both restricted to forests north of Greymouth and Banks Peninsula where the latter once grew at Little Tikau Bay. *P. comans* with broad leaf segments is confined to coastal areas in the Auckland Province.

Though the five members of the genus *Hypolepis* are strictly not brackens they are closely related to them

J. S. Thomson, photo

FIG. 25. The Tree-fern *Dicksonia squarrosa,* showing underground rhizomes

and may be mentioned here, more particularly the two summer-green members (*H. tenuifolia* and *H. millefolium*) with fronds that die down in winter to be replaced the following spring. Though similar in habit and appearance the latter alone has sharply serrated pinnules. The name Hypolepis means 'under a scale' and has reference to the marginal sori which lie under reflexed portions of the frond somewhat reniform in shape. The brackens, on the other hand, have long, linear sori with a covering formed by the long reflexed margins of the frond.

Several other ferns distinct from but related to the brackens are remarkable in their selection of habitats on open hillsides or on rocks where they receive the full insolation of the summer sun without hurt. Such are species of *Cheilanthes, Gymnogramme,* and *Anogramma,* all with marginal sori. Throughout Central Otago, for instance, *C. tenuifolia* will be found on barren rocks, or rather in their crevices, in areas where ferns would never be expected. *C. distans,* the WOOLLY SUN FERN, probably the most xerophytic or drought-resisting fern in the whole flora, is not known south of Banks Peninsula.

Maidenhair Ferns

These ferns belong to the genus *Adiantum,* the name having reference to the fact that water will not wet the surface of the frond. Here the stems of the fronds are usually black and polished. The fronds are generally branched and the pinnules are arranged evenly along the branches, being more or less oblong in shape with numerous crescent-shaped involucres covering the marginal sori on their upper edges. Of six species much the most abundant is *A. affine,* the only one restricted to the New Zealand area. Much the largest member

is the PLUMED MAIDENHAIR (*A. formosum*), a North Island species occurring near Palmerston North, which is capable of attaining a height of four and five feet. The AFRICAN MAIDENHAIR (*A. aethiopicum*) is quite a common northern species, so named because abundant throughout Africa, though it is no less abundant in America and Australia, and indeed in most subtropical lands.

J. S. Thomson, photo

FIG. 26. Colony of Umbrella Fern (*Sticherus cunninghamii*), N.W. Nelson

Umbrella Ferns

The old genus *Gleichenia* has now been split into a number of smaller genera of which there are three in New Zealand. The name Umbrella Fern derives from the habit of certain of the species of spreading out the leafy pinnae in a plane at right angles to the main erect stem or stipes. Of such the finest example is the FOREST UMBRELLA FERN (*Sticherus cunninghamii*) wholly restricted to New Zealand. The main stipes forks at the top, each of these again forks, and so on till there may be sixteen radiating ribs to the umbrella. A second crown may develop above this one, and occasional fronds with four or even five crowns each of decreasing size may be observed. A similar habit may be noted in the FAN FERN (*S. flabellatus*) found only north of Auckland but the pinnae grow upwards in the form of a fan.

The SWAMP FERN (*Gleichenia circinata*) or more correctly the BOG FERN has fronds repeatedly forked (dichotomous), with zigzag wiry branches frequently interlaced, bearing numerous, parallel, linear pinnules fringed with minute sori which are covered by lobes of the pinnules. The larger *G. microphylla* is mainly a North Island plant of similar habit. In peat bogs the swamp fern is particularly abundant and normally under two feet high; but much taller plants occur, while the form known as *G. alpina* rarely exceeds one foot high. *Dicranopteris linearis* or THERMAL UMBRELLA FERN luxuriates in the steam arising from thermal pools or on the warm soil that surrounds them, but is a delicate fern of many tropical and subtropical lands.

Shield Ferns

Typical Shield Ferns have round sori like the polypodies but protected until maturity by a shield or

umbrella-like scale supported by a central stalk. Commonly the fronds are rather coriaceous (leathery) and harsh to the touch, as for instance the PRICKLY SHIELD FERN (*Polystichum vestitum*), a species common at all elevations but specially so in the upper zones of beech forest or in the open shrubberies as well as in the bottoms of upland gullies. This fern has dark-green, rigid, upright fronds over a foot long and shaggy brown scales along the leaf-stalks and midribs. Rather similar, but shorter and with much larger sori, is the ALPINE SHIELD FERN (*P. cystostegia*), a harsh subalpine fern that dies down in winter to renew its fronds once again in the spring.

The BLACK SHIELD FERN (*P. richardi*) is distinguished by the blackish-green colour and sharply toothed leaf segments of the fronds. It is a smaller plant of the forest margins or of roadside banks especially on dry claysoils near the sea. The CLIMBING SHIELD FERN also has leathery fronds but of a brighter green and the shields of the sori are larger and more conspicuous. In any case it is the only one that climbs up the limbs of trees and tree-ferns. Botanically it is *Rumohra adiantiformis*.

The following ferns may be grouped here though they are not strictly true Shield Ferns. The ROUGH-STEMMED SHIELD FERN (*Lastreopsis hispida*) is a more graceful fern with a long stout creeping rhizome from which the somewhat triangular fronds arise to a height of 12 to 18 inches and supported by thin bristly stipes. Not unlike it but with smooth stems and reddish-brown, velvety fronds is the VELVET FERN (*L. velutina*), while the closely allied *L. glabella* has a shorter stipes quite smooth save for a few scales near the base, and a dark-green frond. Quite distinct from these is the tall FEATHER FERN (*Cyclosorus pennigera*) common

in light forest close to streams in shaded localities. It bears numerous small sori close to the midribs of the pinnules. On swamp margins and in gullies it may be as tall as a man. The fronds are pinnate with the longest pinnae in the middle. Occasionally this fern forms a short trunk.

Other Ferns

The PARA OR HORSESHOE FERN (*Marattia salicina*) is often spoken of as the king fern, but this name belongs more appropriately to *Todea barbata,* a close relative of the British royal fern (*Osmunda*) of which we have fossilized representatives at Curio Bay in Southland. Formerly the para, a fern not found south of Taranaki, was plentiful in northern forests before stock and imported game animals gained access to it. The Maoris formerly cultivated it as a food plant. The massive green fronds, normally three to six feet high, have been recorded as attaining a height of twelve feet and a width of five feet. The pinnules are long and about an inch broad, and carry on the lower surface, on either side of the veins, double sori unlike those of any other fern.

The true KING FERN (*Todea barbata*) occurs only in the far north, usually in poor soils in manuka country, though it is also native to Australia and South Africa. It is commonly a small tree-fern with glaucous white undersides on the fronds. Like its relatives the two crepe ferns (*Leptopteris*) it has a primitive type of spore capsule. These latter are represented by the single crepe fern (*L. hymenophylloides*) and the double crepe fern (*L. superba*), the latter also known as the PRINCE OF WALES FEATHERS, two common, dark-coloured but handsome ferns of moderately damp, shady, forest soils.

A climbing fern often forming an almost impenetrable tangle in the forests of the far north is that known as

the MANGE-MANGE (*Lygodium*) which is famous in that it sometimes has a frond one hundred feet long; for what appears to be the principal stem is in reality the wiry midrib of the leaf or frond giving off lateral pinnae capable of forming tendrils to aid it in its upward climb. It was used as cord by the old-time Maori, and as a springy mattress by the wayfarer compelled to sleep out overnight.

The three RUSH FERNS or COMB FERNS (*Schizaea*) could scarcely be more widely separated from the mange-mange in external appearance. Nevertheless they belong to the same fern family. They have erect, wiry leaf-stalks or stipes lacking any leafy expansions. *S. fistulosa* is unbranched, *S. asperula* has a forked frond, and *S. dichotoma* a fan-shaped frond of bifurcating branches. All bear at the extremity a brush of narrow segments which curve over and protect the spore capsules. The first ranges the whole of New Zealand though it is common only in Stewart Island and about Rotorua. The second is not found south of Cook Strait, and the last-named is restricted to kauri country in North Auckland and some of the outlying islands.

Loxsoma cunninghamii is a fern found in dry manuka heath or in light bush in the north. It is a monotypic genus restricted to New Zealand. The fronds are from one to two feet tall, rather rigid, but glaucous white underneath, and are said to emit an unpleasant odour when cut or bruised.

The next two ferns have both a sterile and a fertile frond which die down annually, but are renewed the following spring from a small tuberous root. *Ophioglossum*, the ADDER'S-TONGUE FERN, has two representatives in New Zealand, the commoner one (*O. vulgatum*) having a single undivided leaf and an upright fertile frond with a terminal spike carrying the spores.

It is found on grassy flats and amongst manuka, but is also a subalpine plant. The related MOONWORT (*Botrychium lunaria*) is one of the two species met with in New Zealand. The second (*B. ternatum*) is better known as the PARSLEY FERN, a name that fits its much dissected fronds which may range in length from three to four inches to a foot or more.

CHAPTER VII

HOW PLANTS TELL THEIR STORY

EVERY FEATURE in the structure of a plant bears the impress of the environment in which it has evolved and developed. By a close study of the nature of the response made by plants to various or varying stimuli, it has been possible to learn the significance of the attributes, structures, or organs of the plants around us. Every plant is, as it were, a historian, recording for the discerning the more or less complete story, not only of its own individual development, but also of the race or species of which it is a member. A great part of the pleasure to be derived from forming the acquaintance of the plants of this or any other country lies in one's ability to understand in some measure the language in which they speak to us. A few hints that may prove of service to the reader are given in the notes that follow.

The story of a plant is almost completely a parallel of that of a human individual or family. It records the details of ancestry, relationships, and heredity; of birth and early life; of romance and of marriage; of adaptation to environment; of sickness and disease; of poverty and plenty; of famine and of pestilence; of failure or of success; of friendships and animosities; of the struggle for existence; and finally of death.

Now, though no two historians would be likely to record this story in exactly similar terms, yet their message would be identical. So it is with the individuals comprising any association of plants living in a similar

environment. All will be found to agree in proclaiming the self-same story, but each in its own way.

The same stimulus which brings about a reduction in the size of the leaf in one plant may induce a thick felt of hairs on a second, a waxy covering in the third, or thick mucilaginous sap in the fourth. Thus the student can discern a common history in an association of plants of quite dissimilar aspect.

It is common knowledge that individual plants, like individual races of mankind, can thrive in localities where others would starve or die. Each has certain minimum requirements in the absence of which it is quite unable to thrive or to live. Nevertheless, every plant has a certain power of adaptation to prevailing conditions, and will in some measure attempt to remodel its form and habits to accommodate itself to this changed or changing environment. Indeed it is probably to this plasticity, in conjunction with the hybrid character of many of our plants, that the great diversity of plant forms and species in New Zealand is due.

All parts of the plant respond to environmental changes, but the flowers least of all. The chief of the requirements of plants is a certain minimum supply of moisture, food, light, warmth, and air. Any deficiency below this normal requirement will immediately lead to structural change, and it is therefore possible to reverse the process in one's mind and from the response to deduce the cause.

Of all the needs of the plant, none is more potent in influencing growth than is that of the available water supply. A shortage will in course of time almost certainly cause one or more of the following responses: reduction in the size of the leaves, reduction in the number of the leaves, great increase of the root system,

production of a leaf-covering of wax or hair, fewer or sunken stomata, increased water-storing tissue, mucilaginous sap, or the tussock form wherein the dead interior holds a reservoir of water for the use of the living perimeter.

Reduction in light intensity tends to cause the stems to lengthen, as is so well seen in our lianes and creepers; it likewise stimulates the production of larger, thinner

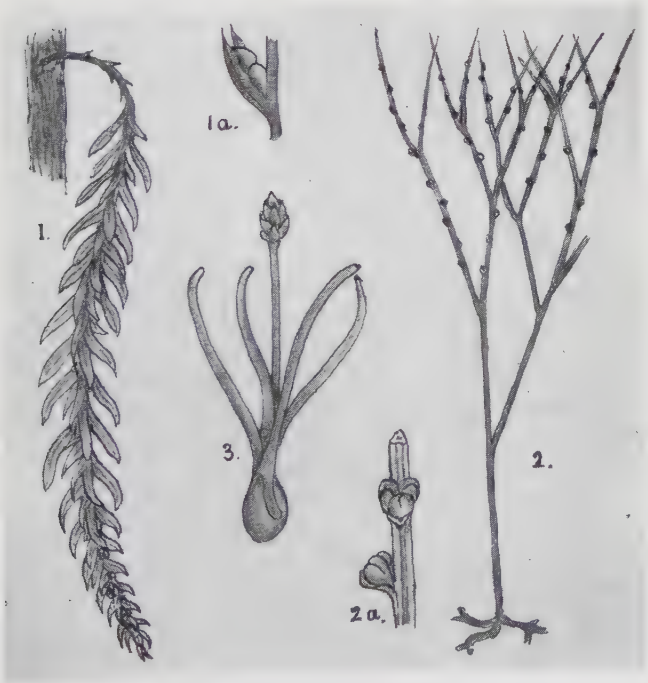


FIG. 27. Living Fossils

1. *Tmesipteris tannensis;* 1a Spore capsules; 2. *Psilotum triquetrum;* 2a. Sport capsules; 3. *Phylloglossum drummondi.*

leaves. Exposure to strong sunlight leads to the dwarfing of plants, a circumstance commonly spoken of as nanism.

Salt in the soil causes succulence such as one notes in most seaside herbs; wind tends to stunt growth, to produce small leaves, and to induce the formation of the tough interlacing stems so well exemplified in the juvenile stages of many of our trees and in the adult stages of many of our shrubs.

Perpetual or periodic drought, coupled with the influence of wind, will often stimulate the formation of spines, e.g., wild irishman, *Hymenanthera,* or *Carmichaelia petriei.* Leaves are often (e.g. Spaniard) developed so that the full rays of glaring sunshine do not fall directly upon them. Clearly the form of the plant then is a function of its habitat and environment.

The makomako or wineberry (*Aristotelia*) is represented in New Zealand by three species, the large-leafed *A. serrata* of the lowland rain-forests, the small-leafed or leafless *A. fruticosa* of the subalpine belt, and *A. colensoi,* an intermediate hybrid species, commonest in sub-alpine forest. This is paralleled by the seven species of tutu (*Coriaria*). Indeed, in very many genera of plants the same phenomenon of reduced leaf-form in the sub-alpine and alpine shrubs is manifest, and in none is it better demonstrated than in the *Hebes* or koromikos.

In this connection may be cited a large number of our trees which, as juveniles, have a different habit and a different leaf-form from the mature tree. The kowhai (*Edwardsia*), the kaikomako (*Pennantia*), the milk tree (*Paratrophis*), the lacebark (*Hoheria*), and the *pokaka* (*Elaeocarpus*) as young trees have tough, tortuous, interlacing stems and small leaves; but as mature trees the stems straighten and the leaves change

in shape and increase in size, so affording an excellent illustration of the well-known fact that individuals, plant or animal, recapitulate in their own development all the changes that the race to which they belong has gone through in past ages. Mutation can be induced by various means, however, resulting in new life forms.

The intense cold and the rigorous continental climate endured by New Zealand during the period previous to the present geological period (the Pleistocene) is reflected in the whole character of the juvenile stages of many of our trees. On the depression of the land and the return of a milder climate, these trees have acquired a greater transpiring surface in conformity with the altered conditions.

The point that stands out clearly is the fact that every feature of the plant has a meaning capable of interpretation by the student of nature. By subjecting a plant to various stimuli and noting the response, much, as we have said already, has been learned; but the most outstanding fact of all is that nothing is reflected in the anatomy and form of a plant so rapidly or so permanently as the amount and variation of the available water supply.

The word 'available' is here used advisedly, for a plant may be surrounded by water and yet be dying of thirst. The existence of sufficient water is one thing; its availability may be a quite different thing.

Let us recall how a plant absorbs moisture. Filmy ferns, mosses, liverworts, and some submerged water plants excepted, which take in moisture through their leaves, most plants absorb moisture through their roots by a process called osmosis. Whether the moisture in the soil will enter at all depends on a variety of conditions. If the water is strongly acid, or saline, or very cold or even very hot, osmosis is hindered or checked

altogether, so that the loss by evaporation from the leaves is not balanced by absorption at the roots. In consequence the plant wilts, and if the condition continues it may even die.

Rushes growing in a bog or tidal estuary may be no more able to secure water than if growing on a dry hillside, or on a sand dune. In one case the drought is physical, in the other physiological. Similarly, adaptations against drought are seen in subalpine plants where the soils for long periods are very cold or even frozen; in brackish swamps where the water is strongly saline; or in bogs where the water is stained dark brown with humic acid, etc. Viewed in this light apparent anomalies frequently vanish. It accounts for species of bush-flax (*Astelia*) growing equally well on coastal rocks, on the trunks of trees, or in the neighbourhood of thermal springs; or for many other plants growing equally well on dune sands and on barren clay hills.

Modifications are called into existence to ensure a balance between root absorption and leaf transpiration. The usual features of drought resistance are in general reflected in a great increase in the root system, a reduction in the leaf surface, in some modification of the leaves to hinder the escape of water by evaporation, or in the development of devices for storing up water.

In the driest stations it is not uncommon to find plants wholly devoid of leaves, e.g., the leafless clematis, leafless lawyer, several native brooms, the matagouri, or the leafless pohuehue (*Muehlenbeckia ephedrioides*) so abundant on the sea shores and shingly riverbeds of Canterbury and Marlborough.

Or again, leaves may be present but reduced to scales, such as we find in the whipcord veronicas, the white and the red pines, or the scabweeds (*Raoulia*) growing in circular patches, e.g., in the driest areas of Otago and Canterbury.

W. Martin, photo

FIG. 28. Matagouri (*Discaria toumatou*), a spinous shrub of grasslands and river flats

That a covering of felty or woolly hairs is a very effective adaptation to prevent evaporation may be proved by the long time such leaves take to wilt. This is well seen in the mountain daisies (*Celmisia*) or in the cudweed (*Gnaphalium*). In the 'Vegetable Sheep' the leaves are not only woolly but crowded so tightly on closely placed stems that their margins at most are exposed. Even the stomata or pores on the leaf-surfaces of plants are sometimes sunk in grooves or reduced in number, or otherwise modified.

The deciduous habit is adopted by some plants (e.g., the fuchsia, some lacebarks, olearias), so that they are leafless when osmotic absorption is so greatly reduced as to imperil the life of the tree. The mountain lily (*Ranunculus lyallii*) and several ferns (e.g., *Hypolepis*), besides various eyebrights, shingle-scree plants, and others, die down in the winter but send up fresh shoots in the spring for a similar reason.

Combinations of conditions often result in the majority of species growing in any association of plants developing similar forms or structures. Thus near the sea many plants are succulent; in windy subalpine areas the zigzag or divaricating shrub form is characteristic, as are the cushion and rush forms in bogs, or the tussock form on dry wind-swept hillsides.

Where conditions change rapidly, e.g., round a brackish lagoon, a marked zonation of the vegetation can be very clearly seen. Equally well is it seen on a mountain side with the tree form giving place to the shrub, and later to the herbs as we ascend into the mist-belt.

The fact that many plants are restricted to very limited stations is mainly a reflex of the same law. The pingao never leaves the sand dune, nor the vegetable sheep its barren mountain rock or scree.

Every feature of the plant must be finely adjusted to the local environment if that plant is to succeed, and there is much of interest in many otherwise unlovely plants.

There remains yet another fascinating study to which we can but allude at present, for on closer examination we learn that one plant or association of plants can and does prepare the conditions necessary for the establishment of a totally distinct association. The scabweed on the river shingle may so stabilize the substratum as to make possible the growth of other plants, and so we may note by slow degrees a transition from shingle scree through fell-field to the alpine herb-field or the tussock grassland. Amongst the bracken clothing a hillside manuka may find a congenial home. Later on, the seeds of forest trees establish themselves in the shade and shelter of the manuka, and so in course of time the manuka gives place to forest or shrubland. Even then changes may go on, one association of plants succeeding another till at last the 'climax association' is reached. So we see that just as individuals and nations of men have their day, so in like manner do individual plants and associations of plants. It may be gathered from this, that in plant life as in the lives of men, current history is no less interesting than the history of the past.

CHAPTER VIII

GRASSES, RUSHES AND SEDGES

NEARLY ONE-SIXTH of all the flowering plants native to New Zealand are species of grasses, sedges, and rushes; and within each of these groups some are dominant, physiognomic plants over wide tracts of territory. The sedges, constituting an intermediate group between the grasses on the one hand and the rushes on the other, are most readily distinguished by such characteristic attributes as the following. They have solid, jointless stems commonly triangular in cross-section which grasses never have. Their leaf-sheaths are not split down one side as in grasses and no ligule separates the blade from its sheath. The characteristic membrane or palea that encloses each grass flower has no counterpart in the sedge, while sedges have their leaves arranged as a rule in three rows as compared with two rows in the grass. From both, rushes are to be distinguished in the possession of flowers having six stamens as against two or three in grasses and sedges. In some grasses (e.g. *Danthonia*) the ligule separating the blade from the sheath is reduced to a row or to two tufts of hairs, and in a few instances it may be altogether absent. If we include certain rush-like plants such as the JOINTED RUSH (*Leptocarpus*), grasses alone have solid nodes at intervals along the culm (flower-stalk).

It has always to be borne in mind that popular names frequently ignore botanical distinctions. Thus the Mt. Cook lily is a buttercup, the Chatham Island lily is a forget-me-not, Native Holly is a daisy, Irish moss is a

seaweed, and club-moss is a lycopod. In like manner many sedges are termed cutty-grasses, and others spike-rushes or twig-rushes. There is, of course, no serious objection to this so long as other people clearly understand what plants are referred to, as when a clover is well known as cow-grass or the common plantain as rib-grass.

The Native Grasses

Introduced grasses now cover most of the arable land where once the native tussocks dominated the landscape or where forest has been cleared away; but there still remain many millions of acres of tussock country chiefly in hilly and subalpine areas. Of one hundred and thirty or more native grasses, half belong to 'tall tussock' country and half to 'low tussock' grasslands, always excepting a few associated with coastal or forest habitats, rock, shingle, scree, riverbeds, swamps, and lagoons.

The tall tussocks referred to are the SNOW TUSSOCK (*Danthonia flavescens*) the RED TUSSOCK (*D. rigida*), and in smaller amount (*D. cunninghamii*); and the 'low tussocks' are chiefly the SILVER TUSSOCK (*Poa caespitosa*) and the FESCUE TUSSOCK (*Festuca novae-zelandiae*), or more rarely *Poa colensoi*, the BLUE TUSSOCK. The name 'tussock' is applied to those tufted grasses which hold water in the decaying leaves at the base. Tall tussock is dominant in subalpine regions and low tussock in montane and lowland country, though in Southland the red tussock reaches sea level and dominates much of the landscape.

The largest of the native grasses are the two TOETOES (*Arundo conspicua* and *A. fulvida*, to use the generally recognised botanical names). These resemble the well-known introduced pampas grass, though they are

somewhat smaller, and abound on swamps and sandhills. The habits of the native grasses are very varied. Many are mat-formers or tussocks, and others are twitches, climbers, or even cushion-formers. Some occupy extensive, more or less continuous areas, while others form isolated tufts; some are restricted to swamps, or to forest, and even to shingle, sand, or fell-field. Some are strictly lowland plants and other are strictly subalpine.

Besides the tall Snow Grass and the larger MOUNTAIN TOETOE (*D. cunninghamii*) other smaller species of *Danthonia* occupy extensive areas of the subalpine grasslands of the South Island. Many acres of the alpine regions of Canterbury and Nelson are covered with the HASSOCK GRASS (*D. australis*) also known as the CARPET GRASS. These occur as a rule where snow lies long in winter, usually on sloping ground; here the hassock grass forms a continuous carpet of leafy stems, the leaves all lying prostrate and pointing downhill. This greatly facilitates the removal of the melting snow cover, but provides a very precarious foothold for the tramper, owing to the polished surface and rigid, wiry consistency of the leaves. On the drier mountains of both islands the WIRY DANTHONIA (*D. setifolia*), so called because of the stiff, erect, acicular leaves, is the commoner species over wide areas. In Marlborough it is sometimes termed the NEEDLE GRASS, a name that is also and more aptly applied to a smaller cushion-forming plant of limestone country in the north of the South Island known as *Poa acicularifolia*.

The genus *Poa* with more than thirty species is the largest genus of New Zealand grasses. Of the montane and alpine species mention may be made of *P. anceps*, a bushy, leafy grass forming quite an important constituent of the grasslands of the Volcanic Plateau; of

W. Martin, del.

FIG. 29. Indigenous Grasses

1. *Festuca novae-zelandiae*; 2. *Poa sclerophylla*; 3. *Poa novae-zelandiae*; 4. *Puccinellia stricta*; 5. *Festuca littoralis*; 6. *Agrostis subulata*; 7. *Danthonia setifolia*; 8. *Triodia exigua*; 9. *Deyeuxia crinita*; 10. *Poa astoni*; 11. *Echinopogon ovatus*.

P. kirkii and *P. lindsayi,* two tufted species much loved by browsing animals, but neither forming a sward; of *P. maniototo,* a pigmy grass covering many acres of Central Otago and the Mackenzie Plains in Canterbury; and lastly of *P. sclerophylla,* unique in its selection of shingle scree as its sole habitat, where it occurs as isolated tufts.

Swamplands are populated by sedges rather than by grasses; nevertheless the toetoe (*Arundo conspicua*) is a frequent and physiognomic (characteristic) plant of wet soils. Moist soils both on coastal cliffs and in subalpine valleys are the usual station of KARETU or SCENTED HOLY GRASS (*Hierochloe antarctica*) and in subalpine areas only of the smaller *H. fraseri.* In the former the leaves are long, broad, and glossy; in the latter they are short, much narrower, and duller but otherwise similar. Both have drooping panicles, bushy in the karetu, slender and few-flowered in the ALPINE HOLY GRASS.

Much the commonest forest-frequenting grass is the BUSH RICE GRASS (*Microlaena avenacea*) easily recognised by its large, green, flat, spreading leaves, its large feathery panicle, and small spikelets. It is sometimes referred to as the FOREST OAT GRASS. Its usual form is that of a large bushy tuft, but on the Coromandel Peninsula a form occurs with branching rhizomes which initiate new plants by vegetative means. A tall, very graceful grass of scrub or of the forest margin (*Oryzopsis rigida*) with slender bamboo-like stems and graceful slender erect panicles, is sometimes grown in gardens as an ornamental grass.

Coastal sandhills have several characteristic grasses of which the SILVERY SAND GRASS or SPINIFEX (*S. hirsutus*) restricted to areas north from Nelson and Marlborough, is quite unlike any other. It is silvery in colour, and coated with short hairs; but its trailing

stems with long fibrous roots make it an excellent sand-binder. Male and female plants are quite distinct. The former has a terminal cluster of stalked male spikelets and the latter, a somewhat globular head of long sharp spines with the female spikelets concealed near the base. When the seed is ripe these heads become detached and roll along before the wind, distributing the seeds en route. The SAND FESCUE has a tufted habit and an erect spike with large turgid spikelets devoid of leafy bracts. The leaves are polished and terete. Another common grass is the WIND GRASS or SAND-BENT (*Deyeuxia billardieri*) recognised at once by its erect, bushy habit and by its broad, lax, feathery panicles. Saline flats bordering tidal inlets are the usual location for several species of *Puccinellia* of which the SALT GRASS (*P. stricta*) with narrow, stiff, tufted leaf-blades and wider sheaths is the most common species.

Soils of poor quality both upland and lowland are commonly known as *Danthonia* country, by which is inferred their poor quality. It is here that *D. semiannularis* and *D. penicillata* (*D. pilosa*) are the dominant species. A common associate is the PLUME-GRASS (*Deyeuxia crinita*), a tall, tufted annual grass with a long, terminal, dense spike with long projecting hair-like awns.

The Sedges

Besides a number of introduced sedges, there are more than one hundred and thirty indigenous to New Zealand, ranging in size from giant Gahnias twelve feet high to the tiny *Scirpus bacillaris* only half an inch high. Three massive sedges best known as NIGGER-HEADS (*Carex secta, C. virgata,* and *C. appressa*) are very similar in general appearance, with huge leafy tussocks raised high on short but stout fibrous trunks above the swampy

ground or stream margins where they are generally found. On Chatham Island the writer has observed such nigger-heads over nine feet high.

Two shorter but robust sedges of coastal areas north of Otago usually known as MARISCUS SEDGES (*Cyperus ustulatus* and *C. congestus*) commonly grow in colonies on moist soils. Each plant is from three to four feet tall with long, flat, tapering leaves, but rendered very conspicuous by the very dark heads of clustered flower spikes surrounded by long leafy bracts and supported on a stout triangular stem. In the former species these spikes are numerous and stalked, in the latter fewer and sessile.

However, much the largest of the sedges belong to the genus *Gahnia* and inhabit the forested areas of the North Island and West Coast of the South Island. Tallest of them all is *G. xanthocarpa,* a giant cutty-grass abundant in kauri forests and a formidable barrier to progress on account of the razor sharp leaf margins. All Gahnias have branching panicles from which the ripe 'seeds' or nutlets are usually suspended on thread-like filaments. In *G. xanthocarpa* these nutlets are yellow at first but later turn black. Next in size come *G. setifolia* with smaller, highly polished, red-brown nutlets and leaves as sharp as in the former species. *G. procera* is a smaller plant that ranges south into Stewart Island where it is the sole species; and *G. gahniaeformis* is still smaller with leaves less than a foot long and a stiff erect flower-spike, reddish-brown in colour and about nine inches long. This is common in the north but rare in the South Island.

Several quite tall sedges of more slender form are restricted to heath soils and swamp margins in the Auckland Province. Of these, mention may be made of *Lepidosperma laterale,* two to four feet tall with short

FIG. 30. New Zealand Sedges

1. *Carex resectans*; 2. *Scirpus lacustris*; 3. *Uncinia fusco-vaginata*; 4. *Carex inversa*; 5. *Carex petriei*; 6. *Schoenus pauciflorus*; 7. *Scirpus caldwellii*; 8. *Oreobolus pectinatus*; 9. *Carex gaudichaudiana*; 10. *Scirpus nodosus* (fruit only); 11. *Eleocharis sphacelata* (fruit only).

leaves and large, flat, polished stems with razor-sharp margins. This is most abundant on heath and clay soils in the far north. *Chaetanthus articulatum*, however, is a lakeside plant with cylindrical stems and leaves and a large, lax, drooping panicle, which may attain a height of six feet, and is confined to the Auckland Province. Several other species of *Chaetanthus* are known as twig-rushes. Such are smaller rush-like plants with wiry stems usually round but in *C. vauthiera* square in cross-section and terminated by a spike-like head under half an inch long with a rigid subulate bract at the base. *C. sinclairii* is wholly dissimilar to the other species in its broad flat stems and leaves arranged as in the iris or common flax. It is a plant of banks and cliffs both in the uplands and on the coast north from Taranaki and Hawkes Bay. Robust plants may be as much as five feet high. *C. complanatum* is the only other species with flat stems but is a rare plant confined to North Auckland.

The genus *Scirpus* with more than a dozen species is represented on sandhills by the ever present *S. nodosus* which but for two or three basal scales is a leafless sedge with a small solitary, nodose cluster of spikelets near the tip of the stems. It rarely exceeds two feet high. A common sedge of tidal inlets usually surrounded by water at high tide is the glaucous-blue three-angled basket-maker's sedge or three-square (*S. americanus*). A taller species (*S. lacustris*) occupies a similar station near the margins of inland lakes and lagoons. In tidal channels along the sea-coast three species of robust stemmed sedges once grouped as *S. maritimus* but now known to be amply distinct are quite common. They are *S. caldwellii*, *S. medianus*, and *S. perviridis*.

The largest of the spike-rushes is *Eleocharis sphacelata*. This bears a sharp-pointed spike at the end of a tall, robust lance-like stem two or three feet tall.

Though found in all three islands it is rather uncommon save on the margins of lagoons in the North Island.

The HOOK-SEDGES or HOOK-GRASSES (*Uncinia*) are well-known sedges on account of the ease with which their hooked 'seeds' attach themselves to one's clothing or person. Each fruit ends in a stiff hair or bristle with the tip bent back to form a very efficient hook. The existence of such plants in a land which had no native mammals is a matter of considerable interest. Of the forest-frequenting species the commonest and one of the stoutest is *U. uncinata*, easily recognised by the long, grassy, green leaves and by the large fruiting spike commonly six inches long. In Stewart Island the commonest forest species is a purple-leafed hook-sedge known as *U. pedicillata*.

Much the largest genus of local sedges is *Carex* with over sixty distinct species. Some species grow only on sandy beaches, and others only on the mountains near the extreme limits of plant life. Several are confined to forests but the great majority are plants of the swamp or lagoon margin. We have already drawn attention to the Nigger-heads which are much the largest of the Carices. One of the commonest of the cutty-grasses is *C. geminata* (*C. ternaria*) a species that forms extensive colonies in moist hollows, stream margins, and more abundantly in areas subject to periodic inundation near the margins of lagoons. It is a tall grassy sedge, two to four feet tall, with three-angled stems and very numerous pendulous female spikelets, two to five originating at each node. *C. subdola* looks much like it and grows in similar stations, but the lower spikelets are always produced singly. The subalpine equivalent is a smaller sedge with sessile but fewer spikelets.

In the Carices male and female spikelets are usually

distinct and separate or else male and female flowers are on different parts of each spikelet. The former are always thin and slender, the latter stout and robust. The relative position of the male and female flowers is fairly constant for each species, also the number (2 or 3) of styles that persist on the apex of each nutlet, and the shape of the nutlet itself.

Grassland Carices include dwarf *C. breviculmis* looking very like a pasture grass; *C. colensoi, C. inversa* and *C. lucida* with flower stems that lengthen greatly as the fruits ripen, in the latter case to as much as five feet; and a reddish, rather larger, erect species (*C. buchanani*), with more or less cylindrical leaves, which is common on the valley floors of upland grassland. There are several species with this red-purple hue of which *C. berggreni* is typical. This is a small sedge with blunt strap-shaped leaves usually found on the margin of slow-flowing rills in mountain areas.

The commonest of the forest-frequenting Carices is *C. dissita,* a plant with broad, flat, grassy leaves and tall culms up to thirty inches high with a solitary male spikelet at the top and four to eight female spikelets lower down.

High mountain species are always very small, and include *C. enysii,* which reaches 6,000 feet on the Craigieburn Range, and the wide-ranging *C. pyrenaica* which occurs at 6,500 feet both on Ruapehu and on the Southern Alps.

Coastal Carices include the CREEPING SAND SEDGE (*C. pumila*) with blue-green leaves and large smooth-beaked utricles; *C. litorosa,* a tall, straw-coloured tussocky sedge of brackish lagoons and the landward margin of sand-dunes; and the massive *C. trifida* found sparingly on South Island shorelines from Picton southwards. It becomes increasingly common as we travel

south and in Auckland and Campbell Island it was formerly abundant. The leaves may be a yard or even two yards long, and the spikelets are exceptionally massive.

Mention has previously been made of the PINGAO, an endemic sand-binding sedge of a golden or reddish colour with spirally arranged spikelets, which occurs abundantly on sandhills throughout New Zealand. On subalpine bogs the commonest sedges are the grassy *Carpha alpina* usually with dead, much-curled leaf tips, and the three COMB-SEDGES (*Oreobolus*) which form dense cushions with the leaves in two ranks.

Finally, there is the FALSE SNOW GRASS (*Schoenus pauciflorus*), a common plant of swampy areas on the mountain sides south from the Volcanic Plateau, which, by reason of its reddish colour and gregarious habit, is easily detected from distances up to a mile.

The Rushes

Our rushes and rush-like plants are comparatively few in species (less than fifty), and are of small economic value. Besides the true rushes restricted to three genera—*Juncus, Luzula,* and *Rostkovia*—there are at least three other rush-like plants that claim mention. The GIANT SWAMP REED (*Lepyrodia*) is restricted to certain swamps of the Auckland Province and to the bogs of Chatham Island. This has stout, polished stems much branched above and bamboo-like in form. In North Auckland, stems ten feet high are not uncommon. Next the WIRE-RUSH (*Hypolaena*) claims attention. This rush-like plant is strictly a bog plant, with slender, wiry, much-branched stems usually about two feet high or rather more. Both in lowland 'pakihi' and in alpine bogs it is commonly associated with the umbrella ferns (*Gleichenia circinata* or *G.*

alpina). This is well exemplified in the Waikato and near Westport and Invercargill, where there are large areas of *Hypolaena*. The third of these bastard-rushes is that known as the JOINTED RUSH, which forms such extensive stands on salt-marsh and saline flats all round the coast. The rush-like stems, three to five feet tall, are crowded on a stout, creeping rhizome and are jointed every few inches, which distinguishes them from true rush stems. Towards winter, *Leptocarpus simplex,* as it is known botanically, acquires a pleasing reddish tint. Inland, it occurs also on the margins of Lakes Taupo, Rotorua, Brunner and various other lakes.

The true rushes other than the subantarctic *Rostkovia* number twenty-five. This is a mountain plant confined in New Zealand to the alpine regions of the centre and west of the South Island. The WOOD-RUSHES comprise eight species of *Luzula* and certain varietal forms, all with grass-like, hairy leaves. Four are species of the high mountains where they form dense cushions on fine comminuted rock up to heights exceeding 7000 feet. The others form grassy tufts at rather lower levels. Commonest of all is the COMMON WOOD-RUSH (*L. campestris*), a polymorphic plant, which however always has broad, hairy leaves ending in a blunt, callous tip, and grows at any altitude from sea level to five thousand feet.

The plants usually called rushes belong to the genus *Juncus* and, including species and varieties, number twenty in all. Of these, only six are conspicuous plants of lowland country, and one of them—the SEA-RUSH (*J. maritimus*)—is restricted to salt-marsh and brackish water north from Otago harbour. The commonest of all the rushes is that known to the Maori as WI-WI (*J. polyanthemos*), always present on the drier swamp soils and generally referred to as the COMMON

RUSH. The largest of all is the GIANT OR PALLID RUSH (*J. pallidus*), and in congenial stations this may have stems over six feet in height and a quarter of an inch thick.

Throughout New Zealand, especially in Canterbury and Otago, and usually in rather drier stations, the SLENDER RUSH (*J. pauciflorus*) forms small, sparse tussocks with very slender, few-flowered stems.

On the banks of streams and ditches, the GRASS-LEAFED RUSH (*J. planifolius*) and the TOAD-RUSH (*J. bufonius*) are ubiquitous species. The ALPINE RUSH (*J. novae-zelandiae*) occurs abundantly in alpine swamps from Taranaki southwards. This is a tiny plant rarely exceeding five or six inches in height. The tufted ANTARCTIC RUSH (*J. antarcticus*), with a similar distribution, alone is smaller.

The raupo or bulrush is of course not a rush at all in spite of its popular name, but mention should be made of the MAORI BURR-REED OR MARU (*Sparganium*), a common rush-like marsh plant in parts of the North Island with flat, strongly-keeled leaves and erect stems up to two feet in height. The flowers are clustered in small, globose heads near the ends of the flower-stalk and its branches, the male flowers uppermost as in many of the Carices.

CHAPTER IX

CLIMBERS, PERCHERS AND PARASITES

THERE ARE in the New Zealand rain-forests, as there are in all tropical forests, vast hordes of plants which are dependent on their neighbours for their very existence. If for the present we ignore the multitudes of ferns and mosses and other spore-bearing plants that grow upon the trunks and limbs of the trees and tree-ferns, we may still discover fully fifty flowering plants that find their most congenial home perched on the limbs or in the forks of the branches of the forest trees, yet robbing them of neither sustenance nor moisture. Such are classed as *epiphytes* to distinguish them from that other class—the *parasites*—which do rob their hosts of the sap intended solely for private use.

The number of flowering plants that can tolerate the deep gloom of a heavily-timbered New Zealand forest is very small. Many of these, however, germinate, and by sacrificing everything else but growth in length they contrive, in the minimum period of time, and with the least expenditure of energy, to reach the light and sunshine above the forest roof; but this is possible only when they are enabled to make use of some neighbouring tree for support. These lianes, as they are termed, are wholly dependent for existence on their ability to reach the light quickly by means of tendrils, hooked prickles, twining stems, and similar devices.

Four or five trees and shrubs frequently start life as epiphytes—e.g., a couple of ratas, an ivy tree, the kamahi, and two broadleafs—but soon produce aerial

roots, which, rapidly descending, ultimately 'take root' in the soil. In the case of the NORTH ISLAND RATA (*Metrosideros robusta*) such roots may coalesce into a spurious trunk, which, either by exercising a strangle grasp on the host or, as has alternatively been suggested, by producing a leafy canopy which deprives its host of adequate light, may ultimately destroy and replace it in forest where otherwise it would probably have failed to secure a footing.

Climbing Plants

If we include scramblers and twining plants as well as those that possess specialized climbing organs such as tendrils, backward directed prickles, or aerial roots, the number of climbing plants will exceed fifty. Any plant which, by any means whatsoever, rushes a stem up to the full light of the forest canopy, using the trees and shrubs for support, and which there anchors itself by copious branching or any other method so that its pendent stem is supported thereby, is termed a liane. It is the abundance of such lianes and perching plants that gives to the forest its tropical aspect more than the presence of tropical trees or shrubs.

Scramblers differ only in that they merely spread their leafy stems over small trees and shrubs on the forest margin and subsequently keep pace with any further growth these may make. Some of them are assisted by a tendency to twine round any support for better anchorage. To this group belong several species of lawyer (*Rubus*), *Convolvulus, Parsonsia,* and Pohuehue as well as others of lesser importance.

The TATARAMOA or COMMON BUSH LAWYER (*Rubus cissoides*) is one of several *Rubus* species that anchor themselves as they climb by means of countless backward pointing prickles, which prevent them from

becoming detached from the support and yet permit unhindered upward growth. It is not uncommon to find pendent stems of the lawyer up to six inches in diameter wholly supported in this way. Two species of *Parsonsia* have a similar habit though lacking the prickles. They are variously termed KAIKU, NATIVE PERIWINKLE, or NEW ZEALAND PERIWINKLE. *P. heterophylla* has wide coriaceous leaves growing in pairs and a terminal inflorescence of fragrant, creamy flowers much beloved of night-flying moths. Juvenile leaves are of two forms, each wholly unlike the adult leaf.

FIG. 31. A white-flowered climbing Rata (*Metrosideros perforata*) growing on a fallen tree

The fruit is a two-valved pod which opens from the tip downwards. As these valves bend outwards they raise the seeds to such a position as permits their dispersal by the wind. *P. capsularis* has narrow leaves and either white or pink flowers.

Two species of *Convolvulus* are twining plants that scramble over shrubs on the forest margin or other vegetation in open spaces. These are at once known by their pointed, heart-shaped leaves and large white bell-shaped flowers. Both are showy perennials most difficult to eradicate when once they gain entry into a private garden or garden hedge.

So dense are the leafy mantles of the POHUEHUE (*Muehlenbeckia australis*) that they tend to smother and sometimes kill the shrubs and trees that support them. Like the *Convolvulus,* this demands full light and does not grow within the forest. It belongs to the dock family and develops spurious, white, translucent fruits consisting entirely of the swollen fleshy perianth leaves. Other well-known scramblers include the CLIMBING FUCHSIA (*F. perscandens*), the slender CLIMBING ANISE (*Angelica geniculata*), and, growing among coastal shrubs, a native spinach called *Tetragonia trigyna,* which, on the margin of Tomahawk Lagoon at Dunedin, the author once observed with stems forty feet long sprawling through and over a patch of local scrub. *Celmisia walkeri,* one of the native mountain daisies, when growing among shrubs shows a tendency in this direction though the stem rarely exceeds four feet.

The native PASSION FRUIT (*Tetrapathaea australis*) is yet another scrambler on forest margins north from Banks Peninsula and Deans Bush in Christchurch. This plant in some ways resembles the Parsonsias but differs in producing its leaves singly with a tendril in each axil. The leaves are large and very glossy, and in late

summer the round orange-yellow fruits are most conspicuous and attractive. They are much smaller than those of the imported commercial passion fruit and are quite inedible.

Showiest of all the climbers is the common BUSH CLEMATIS (*C. paniculata*) harbinger of spring, when its previously unsuspected presence is revealed by cascades of white starry blossoms even high up on forest trees as well as on the lower shrubs. In common with the lawyers, male and female blossoms occur on separate plants, those of the male being the larger and more showy; but the pappus-tailed fruits of the female plants are scarcely less conspicuous than the flowers. A common relative (*C. foetida*) known as MAID MARIAN, contrary to its specific name, is a very fragrant clematis with small yellowish flowers. The smallest species (*C. marata*) is nowhere more common than on the spinous *Matagouri* of riverbed or tussock grassland. A leafless, yellow-stemmed and yellow-flowering clematis restricted to Marlborough and Canterbury bears the appropriate name of *C. afoliata*. Its yellowish, rush-like stems are usually produced on rocky cliffs or hillsides.

Notwithstanding its possession of woody stems and net-veined leaves the SUPPLEJACK (*Rhipogonum scandens*) is a lily commencing life as a sappy upright stem the tip of which rotates till contact is made with some nearby support. Only when the stems reach full sunlight do they produce their leafy branches, their flower clusters, and bright red berries. A thicket of supplejack stems makes progress through the forest difficult and tedious.

Passing next to the root climbers, we find six species of climbing rata and the KIE-KIE (*Freycinetia banksii*) more commonly referred to as the 'giggi'. This latter climber, especially in coastal forests and in valley

J. S. Thomson, photo

FIG. 32. The Kie Kie or 'giggi' (*Freycinetia banksii*) a root-climber of subtropical rain-forests.

bottoms, commonly sprawls over the ground in an almost impassable tangle until, on reaching a well-lighted tree trunk, it commences to ascend when it may attain a height of sixty feet or more, clinging tenaciously by spreading aerial roots in order to support the great weight of leafy branches and rope-like stems. The leaves, two feet or more in length, grow spirally round the stems. The fleshy bracts and fruits are quite edible, a fact of which the old-time Maori was well aware. This climber is absent from the east coast of the South Island, but is abundant on the west coast and throughout the North Island coastal forests.

Climbing ratas are not found other than in New Zealand. Of six indigenous species, two gorgeous climbing ratas are *Metrosideros florida* with orange-red flowers and *M. diffusa* with blossoms of brilliant scarlet. The others have white blossoms sometimes suffused with pink, in the case of *M. hypericifolia,* the only climbing rata found in Otago, where it is known as the WHITE RATA, a name more commonly applied in the North Island to *M. scandens.* In both of these the main stem is firmly attached to the bark of the host tree by numerous aerial roots. The lateral leafy branches on which the flowers are produced are, however, quite devoid of aerial roots, as is the bushy, copiously-branched summit.

Perching Plants

The most numerous and abundant epiphytes of New Zealand forests are the mosses, liverworts, lichens, and ferns, all spore-producing plants which have already been noted; but in addition to these there are fully two dozen flowering plants—trees, shrubs, and herbs—which always or frequently adopt the perching habit. Trees which commence as epiphytes include the NORTH

ISLAND RATA (*M. robusta*), the TWO BROADLEAFS (*Griselinia*), the FIVE-FINGER (*Nothopanax arboreum*), and the KAMAHI (*Weinmannia*). The rata sends down aerial roots which on reaching the ground form a normal root system. As the aerial roots increase in size they ultimately coalesce to form a spurious and most irregular trunk, surrounding the host tree and either by pressure or by the leafy branches overtopping the host tree and shutting out the light, bringing about its ultimate death. It is said that the southern rata (*M. umbellata*) remains a bushy shrub if germination takes place on the ground, but becomes a large tree when germination occurs on a log or tree-fern. The same thing is said to occur in the case of the kamahi; and it is no uncommon thing for the trunk of this tree to commence well above the ground level on massive radiating roots between which one can pass with ease.

The epiphytic shrubs include two very showy members—the SKY-MIST or KOHURANGI of the Maori (*Senecio kirkii*) which when flowering high up on a forest tree can be seen from afar—and the yellow-flowering MATIPO (*Pittosporum kirkii*) a very distinct species unlike any other. The kohurangi is a most beautiful, floriferous shrub with large panicles of white daisy flowers produced in great profusion. In kauri forest, however, and on Rangitoto Island where it is abundant, it is invariably a ground plant and one of the principal ornaments. In such places it is a sparingly-branched, erect shrub five to ten feet high or more, not to be confused with any other. The matipo is likewise a very attractive shrub with purplish stems and whorled leaves up to five inches long and numerous umbels each with up to a dozen yellow flowers. A third epiphyte (*P. cornifolium*) ranges south to Marlborough Sounds, but though distinct is not nearly so attractive. Both matipos

are fully as common on the forest floor as on the upper branches of the trees.

The most conspicuous of the herbaceous epiphytes are two lilies (*Astelia cunninghamii* and *Collospermum hastatum*). When perched high on forest trees they have frequently been referred to as resembling so many nests of some gigantic bird. All perching plants make some provision to maintain or retain a sufficient water supply for long rainless intervals. These two perching lilies use the decaying bases of earlier leaves to form a humus sponge into which the living roots can penetrate to abstract the water absorbed in wet weather. The second plant is even more common on coastal rocks. It has yellowish, three-nerved leaves two to three inches wide and from one to four feet long, whereas the other has green leaves only half as wide but up to five feet long. Neither plant is known south of Nelson and Marlborough. Three flowering orchids (*Dendrobium* and *Earina*), two smaller mat-forming orchids (*Bulbophyllum*), and the creeping *Sarcochilus* are referred to elsewhere. The small forest-frequenting lily (*Enargea parviflora*), most commonly a ground-dweller, is frequently found on the lower portions of tree trunks also.

The Parasites (Mistletoes, etc.)

Parasites are plants which, by reason of lack of chlorophyll and consequent inability to form starchy matter (carbohydrates), have acquired the habit of grafting themselves on to the stems of other plants, and so obtaining the requisite supplies. Only four plants native to New Zealand are wholly parasitic, namely two orchids (*Gastrodia*), *Dactylanthus* a root-parasite, and a leafless twiner. This is the *Cassytha,* restricted to the gum-lands in the far north of the North Island, where it very commonly may be seen smothering

shrubs or tree-branches with yellowish wiry stems, each bearing numerous sucker discs but no leaves other than minute scales. This genus is not found outside the southern hemisphere; and, strange as it may seem, it is a first cousin of the lofty tawa and taraire trees. The New Zealand species (*C. paniculata*) is also an Australian plant.

The eleven mistletoes native to this country are semi-parasites only—that is, they have green stems and leaves, and so are capable of manufacturing in whole or in part such carbohydrates as they require; but they rob the host of the requisite sap and frequently greatly reduce its vitality. That the mistletoe can for a time manufacture adequate carbohydrate has been proved by the writer in the case of the commonest mistletoe of all, the COMMON LORANTH (*Loranthus micranthus*). For over two years all leaves of the host plants (species of *Coprosma*) were cut off, yet neither the mistletoe nor the Coprosma died as a result, which seems to show that the mistletoe must not only take the ascending sap, but give back in return elaborated sap.

The genus *Elytranthe* consists of four species of mistletoes bearing bright red or orange-yellow blossoms, and is restricted in three cases almost wholly to beech trees. The SCARLET MISTLETOE (*Elytranthe colensoi*) bears bright red blossoms in such numbers as to render the otherwise sombre silver beech, to which it is restricted, a no mean rival of the rata. Indeed, some of the clumps of mistletoe are of gigantic proportions, and it sometimes happens that the beech carries a greater surface of mistletoe leaf than of its own leafage. In the South Island the BLACK BEECH and the MOUNTAIN BEECH are the favourite hosts of the somewhat smaller PIRIRANGI (*Elytranthe tetrapetala*), but the

small tree known as quintinia is the more usual host in the North Island. This species has smaller flowers than the former species, but they are bright red in colour, and make most attractive plants on that account.

A duller tinted species (*E. adamsii*) grows near Thames and on the Great Barrier, while a yellow or orange-flowered species (*E. flavida*) known as the YELLOW MISTLETOE is abundant in beech forests south from East Cape. The PIRITA (*Tupeia antarctica*) is the sole representative of its abundant but strictly New Zealand genus. The leaves are narrow, the stems pale grey, and the berries white when ripe. No tree seems immune from its attentions, but strangely enough, the favourite host, the putaweta or marble-leaf, belongs to another monotypic New Zealand genus (*Carpodetus*). The COMMON LORANTH grows quite as readily on acacia, rhododendron, poplar, apple, plum, or hawthorn as it does on any native tree. Both the pirita and the loranth have attractive berries—yellow in the latter case, white in the former—but the flowers of both are small, greenish and inconspicuous.

Two small leafless mistletoes of the genus *Korthalsella* are exceedingly abundant, especially in the South Island. The first, the PYGMY MISTLETOE, has round succulent stems two or three inches long, which bear so great a resemblance to the glasswort (*Salicornia*) of our saline tidal estuaries as to have suggested its specific name of *"salicornioides"*—a burdensome name, no doubt, for so diminutive a shrub. It is generally regarded as rare, but the author's experience is that it is exceedingly abundant and seldom absent from any area especially in the east of the South Island, in which manuka or tea-tree is common, for it is on these trees mainly that this mistletoe makes its home. Bordering the Catlins river the writer has seen acres of manuka, every tree of which was infested with the parasite.

A second species (*K. lindsayi*) has flattened branches functioning as leaves, and grows on a great variety of such shrubs as constitute the zone round the forest margin. *Melicope simplex* is the favourite host plant, but I have seen specimens growing not only on coprosma, kowhai, pohuehue, climbing anise, mapau, but also on an introduced shrub (*Eurybia*), and others growing on another mistletoe (*Loranthus micranthus*). It is no uncommon thing to find *Tupeia* on *Loranthus*, or *Loranthus* on *Tupeia,* but the writer once exhibited to the Otago Institute *Tupeia* on *Loranthus* and *Korthalsella* on *Loranthus* on the same coprosma shrub. Double parasitism is known outside the Dominion, but it is fairly common here.

The whole plant of *K. lindsayi* is rarely more than three or four inches high. Both species grow from tiny seeds that lodge on the branches and there take 'root'. Indeed that is true of all our New Zealand mistletoes. If the fleshy matter be squeezed from off the 'stone' in the seed and this be then pressed against the young bark of the host plant it will usually sprout. Germination is very slow, and hence months may elapse before the seedling is finally anchored. In addition to the taproot sent direct into the host, *Loranthus* and *Elytranthe* develop additional suckers from lateral roots.

Root parasites include three species of *Gastrodia* with tall, erect, unbranched, pale-coloured stems and large tuberous roots, and the sweet-scented *Dactylanthus* which grows on the roots of beech, tarata, five-finger, mapau, and other forest trees and shrubs.

CHAPTER X

THE TREES

PRIOR TO THE ARRIVAL of the pakeha, primeval forests covered much the greater part of the land surface, excluding of course the subalpine and alpine areas and the tussock grasslands. These forests comprised beech forest and subtropical rain-forest, the latter including all the coniferous trees and the associated broad-leafed trees. In general, beech forests dominated the uplands and coniferous forests the lowlands, though mixed forests were common enough.

In all, apart from ferns, mosses, and other spore-bearing plants, some three hundred trees, shrubs, and herbaceous plants were associated in these forests. A third of these were trees and seventy or more were shrubs. Just how unusual these forests are is obvious from the fact that nine plants in every ten are not to be found outside of New Zealand.

If a line be drawn in imagination from just south of East Cape to Kawhia Harbour, it will be found that numerous trees, shrubs, herbs, and ferns are confined to the area north of this. If now another line be drawn from Christchurch to Hokitika, this will also prove the southern boundary line for many more. Trees of the first category include the kauri, taraire, mangeao, tawari, puriri, parapara, monoao, towai, karo, and pohutukawa. Trees that range south to the northern half only of the South Island include the kohekohe, rewa-rewa, tanekaha, toa-toa, maire, nikau, tawa, pukatea, karaka, and titoki. Foveaux Strait proves a

FIG. 33. Juvenile and adult foliage

1. Narrow-leafed lacebark (*Hoheria angustifolia*); 2. Kaikomako (*Pennantia corymbosa*); Southern Kowhai (*Edwardsia microphylla*).

further though less strongly marked boundary beyond which many trees fail to reach Stewart Island. Of such we may note the absence from Stewart Island of all of the beeches, the mahoe, kowhai, tarata, black 'maple', five-finger, pigeonwood, and tea-tree.

A curious fact is that a number of trees and other plants found both in Nelson and in Auckland are completely absent from the southern half of the North Island. Such include the TOA-TOA (*Phyllocladus glaucus*) and its congener the TANEKAHA (*P. trichomanoides*) and the northern NEI-NEI or SPIDER WOOD (*Dracophyllum latifolium*). Several ferns and other plants have a similar distribution.

In all, New Zealand possesses over one hundred and fifty trees of which only half-a-dozen are first-class timber trees in commercial use on a big scale, though others could be, and indeed would be used more generally for special purposes but for their comparative scarcity. Many plants, normally shrubs, occasionally reach the dimensions of trees. If we place the number found to range from Southland to Auckland at forty-six, then we will have to add fifty-two additional members in northern forests, thirty-eight to the central area, but only eleven to southern forests. In round numbers there are 100 trees native to the Auckland Province, 80 native to the central part of New Zealand, and 60 to the southern half of the South Island. This progressive decrease affords a hint of the tropical origin of the ancestors of our present trees and also of the associated plants and animals. The identity of many New Zealand genera of trees, ferns, birds, etc., with those of Polynesia goes far to confirm this supposition.

Not all trees, however, are forest trees, for such as the kowhai, tree-broom (*Chordospartium*), lacebarks, or pohutukawa prefer the open spaces or the well-

W. Martin, del.

FIG. 34. Leaves of New Zealand Trees

1. Ake-ake (*Dodonea*); 2. Kaikomako; 3. Lemonwood; 4. Fuchsia; 5. Putaweta; 6. Manatu (*Plagianthus betulinus*); 7. Taupata (*Coprosma repens*); 8. Hutu (*Ascarina*); 9. Ngaio; 10. Pukatea; 11. Pigeonwood; 12. Southern Rata; 13. Narrow-leafed Laceback; 14. Totara; 15. Black Maire (*juvenile*); 16. White Maire (*Olea lanceolata*); 17. Black Birch; 18. Titoki; 19. Kauri; 20. Kumarahou (*Quintinia*); 21. *Karaka*; 22. Makomako; 23. Toro; 24. Kamahi; 25. Red Birch; 26. Maire (*Fusanus*) and Tawa; 27. Silver Birch; 28. Broadleaf; 29. Hinau; 30. Squeaker (*Suttonia salicina*); 31. Puriri; 32. Tanekaha; 33. Pokaka; 34. Rata (*Metrosideros robusta*); 35. Rewa-rewa; 36. *Eugenia maire;* 37. Rama-rama; 38. Mangrove; 39. Pohutukawa; 40. Whitey-wood; 41. Taraire.

lighted forest margin. Then there are trees such as the pohutukawa, karaka, puka, or ngaio which are rarely seen save on the sea-coasts or nearby, while several of the ribbonwoods or lacebarks are restricted to subalpine areas.

The dominant tall trees of the subtropical rain-forests are the cone-bearing kauri, two species of cedar, and various taxads or so-called pines (white pine, black pine, yellow pine, etc.), numbering in all about a score. The taxads do not produce cones but small nut-like fruits surmounting a coloured, succulent, berry-like aril. With few exceptions the broad-leafed forest trees are evergreens as also are the five species of beech. A very small number of these trees have conspicuous blossoms other than the crimson-flowering ratas, yellow kowhais, pink-flowered kamahi and wineberry, and the white flowering lacebarks, tawari, and whau.

It is not a difficult matter to learn to distinguish all of the native trees, but space is not available for a detailed key. The following table will serve as a guide but should be used in conjunction with one or other of available books giving fuller descriptions. To mark those areas where each tree is to be found the figures 1 to 5 in italic type indicate from north to south the northern and southern half of the North and South Islands respectively, and Stewart Island.

NEW ZEALAND TREES

A. Trees with Pinnate Leaves

1. Towai (*Weinmannia sylvicola*) 3-5 serrate leaflets; leaves in opposite pairs; flowers at or near ends of stems. [*1*]
2. Makamaka (*Ackama rosaefolia*) 7-21 serrate leaflets; leaves pubescent and opposite. [*1*]

3. Kohekohe (*Dysoxylon spectabile*) 7-9 large glossy leaflets with conspicuous veins; flowers on trunk or main stems. [*1, 2, 3*]
4. Titoki (*Alectryon excelsum*) 9-13 leaflets; fruit a capsule opening to expose bright red fleshy cup and jet-black seed. [*1, 2, 3*]
5. Kowhai (*Edwardsia microphylla*) 35-81 leaflets; fruit 4-winged pod. [*1, 2, 3, 4*]
   (*Edwardsia tetraptera*) 25-51 leaflets. Flowers larger. [*2*]

B. Trees with Palmate Leaves

1. Puriri (*Vitex lucens*) 3-5 leaflets, glossy; flowers dull red; fruit bright red. Leaves in opposite pairs. [*1*]
2. Five-finger (*Nothopanax arboreum*) 5-7 stalked, serrate leaflets; leaves large; flowers and fruit in terminal clusters. [*1, 2, 3, 4*]
3. Mountain ivy-tree (*N. colensoi*) 3 or 5 sessile leaflets; leaves large. [*1-5*]
4. Raukawa (*N. edgerleyi*) juvenile 3 leaflets, adult one leaflet; leaves bright glossy green; margin entire; fruit clusters small. [*1-5*]
5. Haumakaroa (*N. simplex*) as for 4 but leaflets serrated and smaller. [*1-5*]
6. Patete (*Schefflera digitata*) 7-9 finely serrated leaflets; flowers in axillary panicles. [*1-5*]
7. Kamahi (*Weinmannia racemosa*) juvenile 3 leaflets, adults 1; flowers in terminal racemes, pink. Leaves opposite. [*1-5*]
8. Houpara (*Pseudopanax lessonii*) 3-5 leaflets sessile at head of very long petiole. Flower clusters terminal. [*1*]
9. Northern lancewood (*P. crassifolium* var. *trifoliolatum*) juvenile plants have trifoliate leaves. [*1*]

C. The Beeches

1. Clinker beech (*Nothofagus truncata*) leaves blunt and serrated; bark very dark in colour. [*1, 3*]
2. Red beech (*N. fusca*) leaves blunt and sharply serrated, 1 to 1½ inches long; larger than for (1). [*1, 2, 3, 4*]
3. Silver beech (*N. menziesii*) leaves serrated but less than ½ inch long. [*1, 2, 3, 4*]
4. Black beech (*N. solandri*) leaves not serrated, base of leaf cuneate, half an inch long more or less. [*2, 3*]
5. Mountain beech (*N. cliffortioides*) leaves entire; smaller than in (4); base of leaf truncate. [*2, 3, 4*]

D. The Conifers

(a) **Pine Family**

1. Kauri (*Agathis australis*) leaves broad to 1½ inches long; female cone globular to 3 in. diam.; male cone cylindric. [*1*]
2. Kawaka (*Libocedrus plumosa*) tree conical, bark flaking, branchlets more or less 4-sided in adult, flat in juvenile; cone ½ inch long. [*1, 3*]
3. Pahautea (*L. bidwillii*) very similar, juvenile branchlets narrower, adult more obviously 4-sided; cones ¼-⅓ inch. [*1-4*]

(b) **Taxads or Yew Family**

I. *Linear leaves*

1. Miro (*Podocarpus ferrugineus*) leaves ½ in. long, often curved, dark green; branchlets flat; fruit ¾ in., purplish and glaucous. [*1-5*]

2. Black pine (*P. spicatus*) leaves rather smaller in adult, linear; branchlets rather flat; fruit small, black, succulent. [*1-5*]
3. Totara (*P. totara*) bark thick and flaking; leaves to 1 in. long; male spikes to 1 in. long; fruit small nut, on red succulent base. [*1-4*]
4. Hall's totara (*P. hallii*) bark thin, papery; leaves larger; male catkins shorter; fruit as above. [*1-5*]

II. *Cladodes functioning as leaves*

1. Tanekaha (*Phyllocladus trichomanoides*) cladodes fan-shaped to 1 inch long, pinnately arranged on branchlets. [*1-3*]
2. Toa-toa (*P. glaucus*) cladodes larger, 2-3 in. long, less obviously fan-shaped as a rule; pinnately arranged. [*1, 3*]
3. Celery pine (*P. alpinus*) cladodes not fan-shaped, ½-2 in. long; not arranged pinnately. [*1-4*]

III. *Leaves (in adult) reduced to scales*

1. Monoao (*Dacrydium kirkii*) juvenile leaves linear, 1 in. or more; adult leaves scale-like, thick, appressed to stem; nuts ⅛ in. long. [*1*]
2. Rimu (*D. cupressinum*) branchlets drooping, leaves scale-like with projecting tips; fruit a nutlet on red fleshy base. [*1-5*]
3. Yellow pine (*D. intermedium*) branchlets with coarse scale-like, projecting leaves; flowers terminal; wood reddish. [*1-5*]
4. Silver pine (*D. colensoi*) branchlets with smaller, appressed leaves; smoother and more slender; wood yellowish white. [*1-4*]

5. Pink pine (*D. biforme*) juvenile leaves linear, ½ in. long; adult scale-like, closely appressed to stem, very small; branchlets 4-sided. [*2-5*]
6. White pine (*Podocarpus dacrydioides*) adult leaves to ⅛ in. long, scarcely appressed on branchlets; fruit fleshy, bright red, with black ovoid nut. [*1-5*]

E. Other Trees

(a) **Trees with blunt or rounded leaf-tips and entire margins**

I. *Coastal trees*

1. Karaka (*Corynocarpus laevigata*) coastal tree; leaves large, 3-8 in. glossy dark-green; fruit large ovoid, orange drupe to 1½ in. long. [*1-3*]
2. Ake-ake (*Dodonaea viscosa*) coastal; leaves alternate about 3 in. long; flowers terminal; fruit a winged orbicular capsule. [*1-3*]
3. Tawapou (*Planchonella costata*, var. *austro-montana*) milky juice; leaves obovate; flowers axillary; fruit large orange-red berry. [*1*]
4. Pohutukawa (*M. excelsa*) coastal tree and shores of inland lakes; leaves 1-4 in., opposite; flowers terminal, larger, dark red. [*1*]
5. Karo (*Pittosporum crassifolium*) coastal; leaf 2½-4 ins., margins recurved, leaves white below; flowers brownish-red terminal. [*1*]
6. Puka (*Meryta sinclairii*) outlying islands only. Leaves to 18 ins. by 10 ins. on long petioles. [*1*]

II. *Inland Trees*

1. Taraire (*Beilschmiedia taraire*) leaves 3-6 in. broad, glaucous below; flowers near tips of stems; fruit dark purple berry. [*1*]
2. Broadleaf (*Griselinia littoralis*) one side of leaf often longer than the other; leaves very broad, yellow-green, 2-4 in. long. [*1-5*]
3. Mangeao (*Litsaea calicaris*) young leaves often reddish, 2-5 in. long; flowers cream-coloured; fruit a berry, ¾ in. long. [*1*]
4. Parapara (*Heimerliodendron brunoniana*) leaves opposite, 4-15 in. long; flowers in terminal clusters; fruits long thin, very viscous. [*1*]
5. Southern quintinia (*Q. acutifolia*) leaves with wavy margins, yellowish with dark-green veins; flowers in lilac racemes. [*1-4*]
6. Toro (*Suttonia salicina*) leaves 3-7 in., obtuse, shiny; flowers on branches below the leaves. [*1-3*]
7. Northern rata (*Metrosideros robusta*) leaves opposite, 1-1½ in.; flowers terminal, dark scarlet. [*1-3*]

(b) **Trees with blunt or rounded leaf-tips and serrated margins**

1. Putaweta (*Carpodetus serratus*) leaves yellow-green with darker green above veins; flowers showy; fruit shining black capsule. [*1-5*]
2. Pukatea (*Laurelia novae-zelandiae*) leaves in opposite pairs, branchlets 4-sided; flowers in axillary racemes. [*1-3*]
3. Kaikomako (*Pennantia corymbosa*) lower half of leaf entire, upper lobed or dentate; juvenile leaves very small. [*1-4*]

4. Savage lancewood (*Pseudopanax ferox*) juvenile leaves over 1 ft. long, reflexed, enlarged at tip; adult leaves 3-6 in. umbels terminal. [*1-4*]

(c) **Trees with acute leaves and entire margins**

1. Eugenia (*E. maire*) bark smooth, white; leaves opposite, 1-2 in.; flowers in terminal clusters; fruit pulpy red berry, ½ in. diam. [*1-3*]
2. White maire (*Olea lanceolata*) bark whitish; leaves narrow, opposite, 2-4 in.; flowers axillary racemes; fruit pulpy, red drupe. [*1-3*]
3. Black maire (*O. cunninghamii*) leaves opposite, broad; flowers axillary; fruit a larger red drupe. [*1-3*]
4. Toru (*Persoonia toru*) leaves 4-8 in., narrow, polished, pale green; flowers dark yellow in axils of upper leaves; fruit oblong reddish drupe. [*1*]
5. Maire or sandalwood (*Mida myrtifolia*) leaves alternate or opposite, 2-3 in., glossy; flowers clustered in axils of leaves; fruit red drupe. [*1-2*]
6. Southern rata (*Metrosideros umbellata*) leaves opposite, 1-3 in. long; flowers crimson in terminal clusters. [*2-5*]
7. Tawa (*Beilschmiedia tawa*) leaves alternate, 2-3½ in., glaucous below; fruit dark purple 'berry' 1 inch long. [*1, 2, 3*]
8. Northern quintinia (*Q. serrata*) leaves 2-2½ in., blotched dark green and red; flowers on long axillary racemes. [*1*]

9. Inaka (*Dracophyllum longifolium*) leaves needle-shaped, 4-10 in. long; flowers clustered at base of leaves. [*2, 3, 4, 5*]
10. Tea-tree or kanuka (*Leptospermum ericoides*) leaves narrow to ½ in., not sharp-pointed; flowers small, in clusters. [*1-4*]
11. Manuka (*L. scoparium*) leaves similar but sharp-pointed; flowers larger and produced singly. [*1-5*]

(d) **Trees with acute leaves and serrated margins**

I. *Flowers terminal*

1. Hutu (*Ascarina lucida*) leaves in opposite pairs, coarsely serrate; fruit a small fleshy drupe. [*1, 2, 3*]
2. Tawari (*Ixerba brexioides*) leaves alternate, opposite, or whorled; flowers very showy, white. [*1*]
3. Milk-tree (*Paratrophis microphylla*) leaves small, crenate, paler below; fruit a very small red drupe. [*1-4*]
4. Large-leafed milk-tree (*P. opaca*) leaves larger, often notched at the base; fruit a larger red drupe ¼ in. diam. [*1-3*]
5. Lancewood (*Pseudopanax crassifolium*) juvenile leaves long, deflexed, adult shorter and broader, stem furrowed. [*1-5*]
6. Kamahi (*Weinmannia racemosa*) racemes often terminal or nearly so; leaves opposite, dull green, coriaceous. [*1-5*]
7. Haumakaroa (*Nothopanax simplex*) juvenile leaves 3-foliolate, adult single 2-4 in. long; usually subalpine. [*1-5*]

8. Lowland ribbonwood (*Plagianthus betulinus*) leaves sharp pointed, coarsely serrate; flowers in large terminal panicles. [*1-5*]

II. *Flowers on twigs below the leaves*

1. Wineberry (*Aristotelia serrata*) leaves doubly serrate, large and broad, opposite pairs; flowers numerous, near tip. [*1-5*]
2. Pokaka (*Elæocarpus hookerianus*) juvenile plants interlacing with very variable leaves; flowers with cleft petals; fruit a purple drupe. [*1-4*]
3. Rewarewa (*Knightia excelsa*) habit of Lombardy poplar; leaves long, coarsely serrate; flowers reddish; petals spirally coiled. [*1-3*]
4. Mahoe (*Melicytus ramiflorus*) wood brittle, bark white; flowers on naked twigs below leaves. [*1-5*]

III. *Flowers in axils of leaves*

1. Whau (*Entelea arborescens*) flowers sometimes terminal; leaves large, more or less cordate; fruits round; capsule covered with stiff bristles. [*1, 2, 3*]
2. Fuchsia (*F. excorticata*) bark papery, flaking, yellowish brown; stem bright green below bark; flowers single, axillary; fruit black ovoid berry. [*1-5*]
3. Narrow-leaved lacebark (*Hoheria angustifolia*) bark can be peeled off in long strips; flowers small, numerous; fruits winged. [*2-4*]
4. Houhere (*H. populnea*) leaves broad, coarsely serrate, 2½-4 in.; flowers white, 1 in. diam., near ends of shoots; fruits winged. [*1*]

5. Long-leaved lacebark (*H. sexstylosa*) leaves narrow but similar, 2-5 in.; flowers numerous in small clusters; fruits winged. [*1-4*]
6. Ngaio (*Myoporum laetum*) leaves with glandular dots; flowers white with purple spots, in leaf axils; fruit small purple drupe. [*1-4*]
7. Pigeonwood (*Hedycarya arborea*) leaves with widely-spaced serrations, opposite, 2-5 in.; fruit a bright red drupe, ½ in. [*1-4*]
8. Northern quintinia (*Q. serrata*) leaves long and narrow, red blotched, margins crimped. [*1*]

The Beeches

New Zealand has five species of evergreen beech trees belonging to the genus *Nothofagus,* elsewhere found only in Tasmania and southern South America. These may be distinguished by their leaves alone, three having leaves with notched margins and two with entire margins. Those with serrated margins are the red beech, clinker beech, and silver beech. The first two have leaves longer than an inch and usually a full inch wide, though those of red beech are rather more pointed and the teeth coarser. Seen in bulk the seeds of red beech are straw-coloured, while those of clinker beech are pale pink. Both produce strong durable timbers which, however, are difficult to season. Silver beech timber decays rapidly in contact with the ground, but is much prized for furniture and interior finishings. The leaves of this tree are rarely longer than half an inch.

Clinker beech ranges from north of Auckland to Nelson and Marlborough, but is commonest in the lowlands and lower montane areas bordering the North Island axial chain, an observation applying also to the black

beech which, however, is not found north of the Coromandel Peninsula nor on the West Coast of the South Island or south of Mid-Canterbury. For a hundred miles south of the Taramakau River in Westland for some unknown reason no beeches are to be found, though beech forests are abundant north and south of this zone.

BLACK BEECH and MOUNTAIN BEECH are very similar, but the leaves of the former are larger as a rule and have a wedge-shaped base, whereas the mountain beech has the base cordate or square cut. Black beech is never found in the upper forests, and mountain beech is rarely found at low levels, save in the west of Nelson and Otago and in the Southland district.

The SILVER BEECH does not form hybrids with the other species, though such are abundant whenever any two of the others grow in one area. It differs also in having entire and not notched cotyledons; it alone acts as host to the Mistletoe (*Elytranthe colensoi*), to the honey fungus (*Armillaria mellea*), or to the strawberry fungus (*Cyttaria spp.*). A small mite often causes the terminal shoots to form disfiguring 'witches' brooms'.

Beech forests so effectively shade the forest floor that few seedlings or ferns are present. Species of the moss *Dicranoloma* may be common enough and even form massive mounds, but lianes are absent, and epiphytes are few except numerous lichens.

The Conifers and Taxads

Notwithstanding the local use of such names as white pine, black pine, or yellow pine, there are no true pines in New Zealand other than the imported species which form our exotic forests. The local conifers other than the kauri were the two cedars—the kawaka

W. Martin, photo

FIG. 35. Juvenile Rimu (*Dacrydium cupressinum*), Stewart Island

and the pahautea. The taxads bear no cones, the 'seed' usually resting on a red or blue, fleshy, berry-like aril as in the yew (*Taxus*).

The kauri is a massive tree related to the Chilean monkey-puzzle and the Australian bunya-bunya, and is restricted to the Auckland province. Being a light-demanding tree it commences life in open spaces and as a juvenile 'ricker' is a conical tree leafy to the base. This form may persist for seventy years but sooner or later, the lower branches fall off and the adult form is ultimately attained which consists of a branch-less trunk for fifty to eighty feet or more, surmounted by a huge, globular, leafy canopy. The trunk does not taper at all, the branches all arising directly from its summit. Kauri trees still exist with more timber than the 300 ft. redwoods of California, or the giant eucalypts of West Australia, and of such excellent quality and all-round utility as to have caused exploitation to the point of partial extinction in the available millable areas. The leaves are flat, thick and usually an inch to an inch and a half long. The male cones and female cones are produced separately on the same tree, the former being thin and cylindrical, and the latter spherical up to three inches across. These have suggested the botanical name *Agathis,* which really means 'a ball of string'.

Every part of the tree exudes a resinous gum when wounded; and because this was formerly in demand for making varnish, it was obtained in quantities up to 10,000 tons annually partly from standing trees, but in vastly greater quantity from the ground in areas from which the kauri has long since vanished. This fossilized gum was of superior quality and was frequently so old that lava flows from Auckland's extinct volcanoes are known to have overlain some of these deposits. The

largest remaining stands of kauri are found in the Waipoua Forest, Trounson Park, and other areas reserved as sanctuaries for the kauri and its associated vegetation.

The only other cone-producing conifers are the two conical cedars mentioned above. They are much alike in external appearance, though the kawaka is the larger tree and has flatter and more plumose or feathery branchlets. It is the commoner species in the North Island as the PAHAUTEA or MOUNTAIN CEDAR is in the South Island, but each overlaps into the territory of the other. The timber of both trees, though rather brittle, is strong, reddish, durable, and easily worked. The reddish or light brown bark usually hangs in long flakes or strips rendering the tree free from epiphytes.

The New Zealand taxads comprise three species of celery pine and seven each of *Podocarpus* and *Dacrydium,* but only a dozen attain tree dimensions. The name CELERY PINE in common usage is almost restricted to *Phyllocladus alpinus,* the others being called the tanekaha and toatoa, both lofty trees found in the Auckland and Nelson provinces but absent from the intervening area. The adult trees of these celery pines have flattened branchlets (phyllodes) in place of true leaves, fan-shaped in the toatoa and tanekaha but so placed on the short branchlets for these to resemble pinnate leaves. The phyllodes of *P. alpinus* are pointed and differently arranged, while the plant is more often a shrub than a tree, and never attains large dimensions. This celery pine or MOUNTAIN TOATOA is an abundant plant in subalpine beech forests and in the lowland forests of Southland and Westland, but is fairly common as far north as Coromandel Peninsula.

The toatoa has much larger phyllodes than the tanekaha, always exceeding an inch in the one and never

equalling an inch in the other; both are very handsome trees.

Of the seven podocarps five are tall timber trees, these being the white pine and the black pine so called, two species of totara, and the miro. As adult trees the miro and black pine can easily be confused, both having flattish branchlets with a double row of flat, strap-shaped, green leaves half an inch long, rather more curved in the miro. The 'fruits' are fleshy, small and black in the matai or black pine, large, reddish purple with a glaucous bloom in the miro. The juvenile in the miro closely resembles the adult, but that of the matai could scarcely be imagined to be the early form of the adult tree, being a twiggy shrub with interlacing branches bearing a few bronze-coloured leaves near the tips. Male and female trees are distinct in all the podocarps. The wood of the matai is of excellent quality and much used for flooring and panelling, that of miro being also hard, durable and straight-grained, but not very suitable for outdoor work.

The two TOTARAS (*Podocarpus totara* and *P. hallii*) are also much alike, though in general the leaves of the latter are somewhat longer and the bark papery instead of flaking off in thick strips as in the true totara. The timber of each is of excellent quality and is easily worked. From the totara, the Maori fashioned canoes and carved panels for the meeting houses. Both have thick, rigid, sharp-pointed leaves about an inch long usually with a bronzy hue, and arranged all round the stems.

Though the KAHIKATEA OR WHITE PINE is a common constituent of forests from the far north to the far south, it nowhere is so abundant or forms such pure stands as when the soil is waterlogged or swampy. It sometimes attains a height of two hundred feet, with an

J. S. Thomson, photo

FIG. 36. Swamp forest of Kahikatea (*Podocarpus dacrydioides*), Westland

unbranched trunk rigidly erect, scarcely tapering, and crowned with a leafy top, ridiculously small for so large a tree. As a juvenile it bears no resemblance to the mature tree, being an erect, bronze-coloured shrub with both long and exceedingly short leafy shoots. The wood is soft, white, and being without odour was much used for containers for butter for export. Much of the wood is sap-wood and is a favourite timber for the common borer (*Anobium*). The adult branches are surrounded by closely appressed scale-like leaves, and when fruiting bear copious small black 'seeds' each resting on a bright-red berry-like base. Such fruiting trees are usually a source of much admiration.

Coming next to the seven species of *Dacrydium,* the RIMU stands first and foremost as the most useful timber tree in New Zealand, kauri excepted. The wood is used for building houses, for furniture, for ornamental panelling, and for numerous other purposes. As a juvenile it has long, green, drooping branches of most attractive appearance, each completely clothed with short projecting scale-like leaves. The branchlets of the adult are similar but shorter. Only above the lower canopy of the forest does it produce its round-headed leafy top. The rimu ranges from the kauri forests of Auckland to the forest-clad slopes of Stewart Island where it is perhaps the dominant tree.

KIRK'S PINE or *monoao* is a tall timber tree of kauri country, remarkable for the abrupt change from the juvenile with leaves up to an inch and a half long, to the adult with scale-leaves, both forms being commonly observed on the same branch. YELLOW PINE and SILVER PINE rather resemble the kahikatea in appearance, but the wood is of more lasting quality. Railway sleepers of both trees last almost indefinitely, as do telegraph poles and posts. Yellow pine has darker

J. S. Thomson, photo

FIG. 37. Juvenile matai or 'black pine' (*Podocarpus spicatus*)

timber, solitary nutlets, and rather more slender branchlets with closely appressed scales, silver pine having the nutlets commonly in pairs and rougher branchlets. The pink pine (*D. biforme*) is so named because, like the manoao, both juvenile and adult leaves are commonly developed on different parts of the same branch, though the juvenile leaves are only half the length of those of the monoao and are restricted to young trees or to reversion shoots. Like the other two just referred to, this tree produces durable wood suitable for damp conditions, but all too often it is little more than a shrub.

To this genus belongs the PYGMY PINE (*D. laxifolium*), the smallest conifer in the world. It is a trailing shrub often fruiting while only three inches high, and usually frequenting subalpine bogs.

Dicotyledonous Trees Ranging from Auckland to Otago

Most New Zealand forests other than beech forest comprise a mixture of conifers and broad-leafed trees. Some of these latter trees have a wide distribution in the two main islands, and many grow in Stewart Island also. Of course each tree has certain minimum requirements in respect to light, soil, climate and competition, so that many may be missing from quite extensive areas. Some cannot grow in dense forest, some can establish themselves only in full light, some grow only near the sea, and other are subalpine in all but southern areas; some are restricted to fertile soils and others to sterile or boggy soils; for which reasons we do not find all species in one association.

On dry heath soils, on the margins of swamps, and on open hillsides MANUKA, more usually a shrub than a tree, is one of our commonest physiognomic plants. It acts as a nursery for many of our smaller trees and these in turn for the larger timber trees. It is only in

Miss Reynolds, photo

FIG. 38. Miro (*Podocarpus ferrugineus*)

competition with these rapidly growing trees that manuka itself becomes a tree. Much the same is true for the KANUKA or TEA-TREE, which the author has seen on Mt. Stokes in Marlborough with stems twelve inches in diameter and sixty feet or more tall; but, owing to the shade cast by the taller beech trees most of these were dead or moribund, kanuka being a tree demanding full sunlight. Manuka produces its flowers singly, kanuka in clusters; the leaves in manuka alone are sharp-tipped. Several mutants of the manuka with pink, red, or double flowers are now much treasured garden shrubs of supreme merit. Both manuka and kanuka are the usual host plants for our smallest mistletoe (*Korthalsella salicornioides*).

Amongst the commoner New Zealand trees are the broadleaf, the five-finger, haumakaroa, raukawa, whitey-wood or mahoe, patete, putaweta, kaikomako, lancewood, kamahi, lemonwood, black maple, mapou, wineberry, pokaka, fuchsia, ribbonwoods (4) and kowhai. Of these many have very distinct juvenile and adult forms. No one observing a young pokaka, kaikomako, haumakaroa, lacebark, or lancewood could possibly recognise the adult trees as belonging to the same species unless both juvenile and adult leaves were present on the same plant.

The kaikomako, also known as CHEESEWOOD and BRIDAL TREE, commences life as a bushy shrub with tortuous, interlacing, tough branches and small leaves with entire margins on the lower half and usually two large notches above. It then makes an abrupt change in which the branches are straight, more brittle, and bearing very much larger leaves with more numerous marginal lobes on the upper half. The flowering panicles form on the ends of the branches, sometimes even on the juvenile branches. This was one of several

trees providing wood suitable for generating fire by friction, the only method known to the ancient Maori.

In the pokaka the distinction between juvenile and adult is even more marked, for there are two main leaf forms on the young plant both most unlike and much smaller than those of mature trees. The pokaka grows into a tall tree with beautiful racemes

Miss Reynolds, photo

FIG. 39. Marble-leaf or Putaweta (*Carpodetus serratus*)

of 'lily of the valley' flowers followed by large purplish drupes. As an adult it closely resembles the hinau, but the leaves are flat, not recurved as there; nor does the juvenile hinau pass through the divaricating shrub stage, its leaves being longer than those of adult trees.

The juvenile lancewood has deflexed leaves 1½-3 ft. long on an erect unbranched stem; but as an adult tree, there is a round head of leafy branches, the leaves no longer long and pendent but shorter, broader, and more or less erect. The SAVAGE LANCEWOOD (*Pseudopanax ferox*), though widely distributed, is much less common. As a juvenile it has long, deflexed leaves like those of the common lancewood, but these have a clubbed tip, and coarse, hooked, marginal teeth.

Sole representative of the endemic and monotypic genus *Carpodetus* is PUTAPUTAWETA or MARBLE-LEAF, with short, wide light-green leaves with darker green above each vein. It is a pretty, floriferous tree and the favourite host for the mistletoe *Tupeia antarctica*, another monotypic genus. A common associate is the TARATA or LEMONWOOD, yellow-flowered and lemon-scented, bearing rather long, undulate leaves with entire margins and conspicuous midribs. Still another associate is the MAHOE or WHITEY-WOOD, likewise known in Otago as HINA HINA, a name often corrupted to 'eenee-eenee'. This small tree has remarkably brittle stems and whitish bark, and flowers clustered on the bare stems below the leaves. Cattle are very fond of the leaves. Though a relative of the common violet, the only resemblance evident is in the violet colour of the berries.

There are two small trees with leaves of similar size and shape, and with undulate margins, known as the MAPOU and the black 'maple' or MATIPO. The mapou has, however, red twigs and red-blotched leaves, those

of the other being dark and green respectively. Mapou has flowers on bare stems below the leafy tips as in the mahoe, while the matipo has terminal purple flowers followed by three-valved capsules which on opening display the black seeds embedded in a viscous secretion. This matipo is not found west of the Alps. It is commonly used as a hedge-plant but does not respond well to clipping.

W. Martin, photo

Fig. 40. Kauri Forest—interior view, Trounson Park

W. Martin, photo

FIG. 41. Kauri Forest—exterior view, Waipoua

Probably no tree is better known than the FUCHSIA on account of the distinctive cinnamon colour of its thin papery bark, the bright green of the underlying stem, and the typical fuchsia flowers. Outside of South America and Mexico, New Zealand is the only country with indigenous fuchsias, one of which is a herb, one a shrub, another a climber, and the fourth a tree. On

the forest margin the TREE TUTU (toot) (*Coriaria arborea*) is a common small tree with fluted stems, and lateral branchlets resembling large, pinnate leaves. The flowers hang in drooping panicles, the perianth later becoming swollen, black and succulent, and encasing the true fruit.

When a forest is felled the first tree to reappear or rather to appear is commonly the MAKOMAKO or WINE-BERRY (*Aristotelia serrata*) a first cousin of the pokaka but of greatly dissimilar aspect. It has large, thin, doubly serrate, acute-pointed leaves, placed in opposite pairs and when young, red-tinted on the lower surface. The pink and red flowers make this a very attractive tree, but one may ask, whence did it come? Was the seed transported or was it lying dormant in the soil, as seems probable?

Next we have the FIVE-FINGER, the THREE-FINGER, the HAUMAKAROA, and the RAUKAWA, all species of *Nothopanax*. Only the first, save in the south, is a low-land tree, the others being montane or subalpine. These belong to the ivy family as also does the seven to nine-fingered PATATE (*Schefflera digitata*). The five-finger (*N. arboreum*) has normally five leaflets per leaf, each attached by a short petiole an inch or so long, whereas the three-finger or MOUNTAIN IVY-TREE has as a rule three sessile leaflets. The other two have trifoliolate, deeply notched, juvenile leaves, but single leaves in the adult, those of the haumakaroa being rather small and dull, whereas those of the raukawa are larger and very glossy. The ANOMALOUS PANAX (*N. anomalum*) could here be mentioned since it is very widespread, but it remains a much branched shrub with roundish, crenate leaves scarcely half an inch long. It much resembles the shrub *Melicope simplex*.

Then mention should be made of the KAMAHI and

BROADLEAF, two abundant trees in New Zealand forests. The former frequently has a three-foliolate juvenile leaf, though frequently these are replaced by a single leaflet. Occasionally both of these plants, like the northern rata, begin life as epiphytes and send down aerial roots which in time coalesce into a spurious trunk. Unlike the rata, however, both can commence life on the ground and develop into trees. The broadleaf, like the elm, commonly has one side of the leaf longer than the other. The leaves are thick, leathery, fairly large, and broad with rounded tips.

Several ribbonwoods or lacebarks are very common lowland trees but only one (*Plagianthus betulinus*) ranges from Stewart Island to Kaitaia. *Hoheria angustifolia* is equally common as far north as the middle of the North Island and *H. sexstylosa* north from Canterbury. *P. betulinus* has deeply notched leaves round at the base, *H. angustifolia,* the narrow-leafed lacebark has very small, narrow serrate leaves, and *H. sexstylosa* the long-leafed lacebark has lanceolate leaves with wedge-shaped bases and evenly toothed margins. All are showy trees in the flowering season by reason of the numerous white flowers produced near the tips of every branch. All have fibrous, tough bark or bast which can be peeled off in long strips and, if need be, used as cordage and all belong to the marsh-mallow family.

No account of the southern trees would be complete without mention of the lovely groves of ribbonwood that form such an attractive feature of the subalpine mountain sides of the Alps. There are two well-known species: *Hoheria glabrata* (formerly known as *Gaya lyallii*) and *H. lyallii* (formerly *Gaya ribifolia*). Both produce large white blossoms in such great profusion that a grove much resembles a cherry orchard. The leaves are deciduous, thin, crenate, cordate, and finely

Miss Reynolds, photo

FIG. 42. Mountain Ribbonwood (*Hoheria lyallii*)

pointed. The latter is the HOARY RIBBONWOOD and has smaller and relatively broader, less pointed leaves than the other. It is restricted to the drier eastern side of the Alps, whereas *H. glabrata* prefers the wetter areas of the west and south-west, nor is it there confined to the higher altitudes.

Another floriferous tree, commonest in the South Island but ranging over the southern half of the North Island as well, is the kowhai (*Edwardsia microphylla*). This has sulphur-yellow flowers with a darker basal cup, deciduous pinnate leaves, and long indehiscent pods constricted between each of the seeds. There is in central North Island another kowhai (*E. tetraptera*) with larger flowers and leaves which does not become a massive tree, nor does it pass through the same divaricating stage as does the juvenile of the small-leafed congener. In all, there are at least five species of kowhai native to New Zealand, one (*E. prostrata*) commonly remaining as a ball-like or scraggy shrub and bearing much smaller and darker flowers. Posts and rails of the southern kowhai, cut in the early days of the dominion, are still sound, but trees cut in spring are said to lack this lasting quality.

The PIGEONWOOD and QUINTINIA are widespread trees, being specially abundant in Westland. Quintinia does not appear east of the Alps nor pigeonwood south of Banks Peninsula. This has dull green leaves with far-spaced marginal serrations and bright red drupes much eaten by the native pigeon. *Quintinia* has wavy leaves 3 to 6 inches long, yellow-green in colour with darker green veins. The terminal racemes overtop the leaves, their pale lilac tint being quite pleasing.

Two common trees of the coastal forests of the West Coast of the South Island are the HUTU or ASCARINA and the southern *Quintinia*. One or two trees of the

W. Martin, photo

FIG. 43. Southern Kowhai (*Edwardsia microphylla*) with both juvenile (bottom branch) and adult foliage

hutu are present on Mt. Anglem in Stewart Island and it also occurs sparingly in the North Island. The *Quintinia,* however, does not occur in Stewart Island nor in the Wellington Province but reappears in the Coromandel area and on the Great Barrier Island. The former is a bushy tree with opposite leaves very sharply serrated, and with very dark-coloured bark. The *Quintinia* on the other hand has long undulate leaves with almost entire margins, and each grows singly. The long, pale lilac racemes grow amongst the terminal leaves.

A tree commonest on the islands off the Auckland Coast but now rather uncommon on the mainland save in cultivation, is known as the Whau (*Entelea arborescens*). This has large, thin, serrated leaves on long petioles and in summer bears numerous white flowers each a full inch in diameter followed by globose, prickly fruits an inch wide. All parts of the plant when young are covered with stellate hairs and the wood is lighter than cork, for which reason the old-time Maori used it for floats for his fishing nets.

Deciduous Trees

Trees and shrubs tend to develop the deciduous habit when conditions are such as would prevent adequate absorption by the roots to balance the normal evaporation from the leaves. This condition may be induced either by extreme heat in summer, or great cold in winter. Deciduous trees and shrubs or such as are partially deciduous are commoner in the south of New Zealand than in the north, and number in all about two dozen apart from a few herbs and ferns.

It is possible, however, that this habit arose in response to a previous more rigorous climate such as characterized the Pleistocene epoch, for it is no un-

Miss Reynolds, photo

Fig. 44. Kaikomako (*Pennantia corymbosa*), adult foliage and fruit

common experience to observe evergreen and deciduous trees to grow side by side. The fuchsia is rarely seen devoid of leaves in the north, but this commonly occurs in Otago. Defoliation in the case of the kowhai occurs just prior to flowering and possibly has nothing to do with the climatic conditions. The following trees and

Miss Reynolds, photo

Fig. 45. Large-leafed Kowhai (*Edwardsia tetraptera*)

Miss Reynolds, photo

FIG. 46. Scarlet Mistletoe (*Elytranthe Colensoi*)

shrubs are always deciduous—the LOWLAND RIBBONWOOD (*Plagianthus*), HOARY RIBBONWOOD (*H. lyallii*), *Senecio hectori, Olearia fragrantissima, O. hectori, O. lineata,* and *O. divaricata.*

Dicotyledonous Trees of Southern New Zealand

Besides those wide-ranging trees already referred to, there are a number of typically South Island trees, several of which also cross Cook Strait. Foremost of these is the SOUTHERN RATA (*Metrosideros umbellata*) to which no other New Zealand tree is superior in the brilliance of its blossoms. The North Island rata and the pohutukawa are far famed for their crimson blossoms, but neither is so vivid as the southern rata when covered with its fiery red flowers. A hillside in a good flowering year (about one in three) when the rata is in full bloom is a sight not easily forgotten.

This tree, unlike the northern rata, rarely commences life as an epiphyte but usually on the ground, on logs, or on rocks. It is most abundant in Stewart Island and on the west coast of the South Island. On the east coast it is absent north of the mouth of the Taieri River, and in the North Island is confined to the mountains. At least eight individual trees are known with yellow flowers replacing the usual scarlet.

Reference has already been made to the PINE-APPLE TREE of the western uplands of Nelson and Westland, otherwise known as the NEI-NEI or less commonly as the SPIDER-WOOD. It is a larger tree than the nei-nei of the kauri forests, and once seen can be recognized immediately from the long branches each terminated in a tuft of recurving leaves bearing a very strong resemblance in appearance to the tropical pine-apple. The flower clusters which arise from the centre of each tuft, though reddish, are not specially attractive. The GRASS-TREE

or INANGA (*D. longifolium*) is yet another species of *Dracophyllum* which on occasion can become quite a fair-sized tree. In Stewart Island it is very common indeed, erect when growing in the shelter of forest trees, but much more frequently semi-prostrate and of very irregular form. It is usually a mountain plant north of Dunedin as far as East Cape, but in Campbell Island it is the dominant tree. The leaves, 9 or 10 inches long,

W. Martin, photo

FIG. 47. Mountain Mop or Nei-nei (*Dracophyllum traversii*)

are again clustered at the tips of the branches; but, as they usually remain rigidly erect and are narrow and grassy with a broad sheathing base, the tree has a very different aspect from the broader-leafed nei-nei. Though normally a shrub it can attain a height of thirty feet and have a trunk almost a foot in diameter.

In the upland beech forests, there is a lancewood never seen at low levels save occasionally in the Sounds

area of Otago. This is the MOUNTAIN LANCEWOOD (*Pseudopanax lineare*) which differs from other lancewoods in the smaller dimensions of its leaves which are never deflexed. Adult leaves may be only two inches long. Though a full-grown plant may be ten to twelve feet high, it is hardly worthy of the title, tree.

The TREE BROOM (*Chordospartium stevensonii*), confined to central Marlborough is probably represented by fewer than a hundred trees. Each trunk forks near the ground into two or three main limbs, which fork and refork to form a ball-like tree with pendulous leafless branches bearing pale lavender flowers in the summer months. It forms an excellent garden subject. Both the genus and species are endemic to New Zealand.

Monocotyledonous Trees

Three trees that impart a unique character to the landscape are the NIKAU PALM and two species of CABBAGE TREE. The nikau ranges south to Greymouth and Banks Peninsula, being very abundant from Punakaika to Westport and in many parts of the North Island. The flowering branches are formed at the base of the lower leaves and give rise to bright red berry-like fruits. The Maori formerly ate the unexpanded central bud and also the young spadix.

The common CABBAGE TREE (*Cordyline australis*) is a most abundant plant in swamps, and on open hillsides, flood plains, and forest margins. The trunk is very rugose and up to three feet thick. Young plants are unbranched but older trees carry a round-headed crown with numerous stems each ending in a bunch of grass-like leaves. *Cordyline indivisa* is a broad-leafed tree rarely branched but bearing a massive head of ensiform leaves, often six inches broad and up to six feet long. It is a very attractive plant of upland forests north from

Miss Reynolds, photo

FIG. 48. Puriri (*Vitex lucens*), a beautiful tree from Auckland Province

Banks Peninsula on the east coast but ranging south to the sounds of western Otago. It is specially common on the Volcanic Plateau. Normally it does not greatly exceed ten feet high in the open but in subalpine forests it may exceed thirty feet in rare instances. The other three species are little more than 'shrubs', *C. banksii* being noted for its beautiful flower panicles and delicious fragrance.

W. Martin, photo

FIG. 49. Nikau Palms

CHAPTER XI

THE SHRUBS

OUTSIDE THE TROPICS few countries are so richly endowed with ornamental foliage shrubs as New Zealand. However, the forest-frequenting shrubs with only a few exceptions possess little horticultural merit. These exceptions would include the floriferous *Senecio kirkii,* several species of *Alseuosmia,* and the TAUREPO OR FOREST ABUTILON (*Rhabdothamnus solandri*). Of the Alseuosmias the KARAPAPA (*A. macrophylla*) has the greatest merit. It is closely related to such exotic flowering shrubs as the honeysuckle, guelder rose, and *Weigelia.* The taurepo, a small shrub with opposite leaves and tubular, orange-coloured blossoms, is a relative of the *Gloxinia* whose large, brightly coloured velvety flowers are so much admired in greenhouses and conservatories.

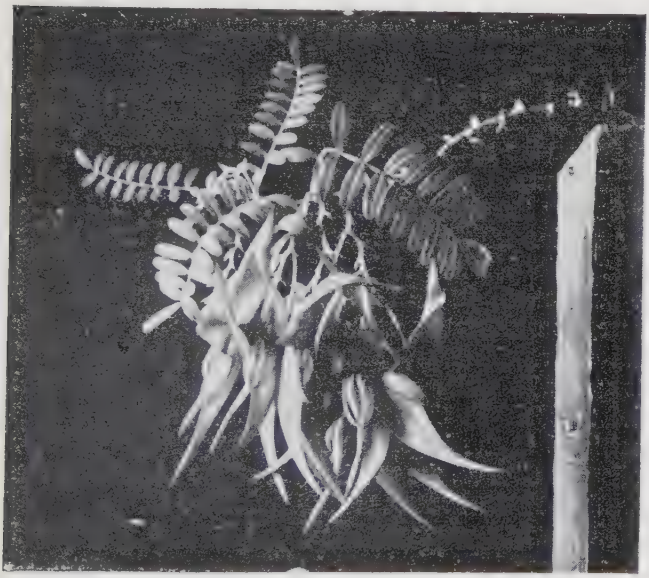
New Zealand is also poorly endowed with brightly coloured flowering shrubs; for, apart from the scarlet and orange-flowered climbing ratas, the only shrubs with bright red flowers worthy of cultivation are the KAKA-BEAK OR RED KOWHAI (*Clianthus puniceus*) and several mutants of the common manuka. *Hebe speciosa* may also be included here, though the flowers are of a deeper and less vivid red. Blue-flowering shrubs are likewise far from numerous, and are restricted to the genera *Hebe* and *Solanum.* Much the finest of these is *H. benthamii* from Campbell Island with flowers of the deepest and purest blue; but two very similar species of *Solanum* known to the Maori as poro-poro but corrupted

Miss Reynolds, photo

FIG. 50. Kamahi (*Weinmannia racemosa*)

to bulli-bull by the Pakeha are conspicuous coastal shrubs with blue flowers and yellow or orange berries.

Such of the remaining shrubs as are desirable garden plants on account of their flowers no less than their foliage, come either from Marlborough or from the subalpine shrubberies. These Marlborough shrubs



By courtesy L. W. McCaskill

FIG. 51. Kaka-beak (*Clianthus puniceus*), a scarlet-flowered pea now probably extinct in the wild state

include the ROCK DAISY (*Pachystegia insignis*) finest of its tribe, the NEW ZEALAND LILAC (*Hebe hulkeana*), the yellowed-flowered *Senecio monroi,* and the three PINK BROOMS (*Notospartium* spp.). The rock daisy has large, rounded, leathery leaves, white on the underside, and

bears many white flowers up to three inches across. It is a very conspicuous shrub on the roadside cliffs from south of the Conway River to Woodside Creek on the Blenheim highway. The New Zealand Lilac derives its name not from any relationship to the lilac grown in gardens, but from the lavender colour of the long, flowering sprays that terminate the branches.

The so-called pink brooms when covered with pink or lavender blossoms are graceful and showy shrubs six to eight feet high with more or less pendulous, green, leafless branches. Such flowering shrubs in their natural setting on the open hillside can be detected from almost a mile away.

Among the daisy shrubs of the genus *Olearia* there is a section with thick, serrated leaves and large white or lavender blossoms, which, were they more amenable to cultivation, would be found in many gardens. Of these, the CHATHAM ISLAND ASTERS (*O. chathamica* and *O. semidentata*) have numerous purple-centred flowers with white ray florets in the first named and violet 'petals' in the latter. *O. semidentata* is almost restricted to the bogs, but the other prefers the drier soils and cliffs on the south coast of the island. At the junction of the two areas they hybridize freely.

The TETE-A-WEKA of Bluff and Stewart Island and *O. operina* of the West Coast sounds are similar plants. Both have white ray florets, but the former (*O. angustifolia*) has a purple centre and the latter a yellow centre. On the Takaka hills and in the Buller Gorge may be seen one of the finest flowering shrubs in the flora. This is HECTOR'S SENECIO (*O. hectori*), best distinguished by its very large leaves with numerous frilly lobes at the base and by the large panicles of white blossoms each 1½ to 3 inches in diameter.

Another very floriferous shrub to be seen on the

W. Renwick, photo

FIG. 52. Purple-centred Chatham Island Aster (*Olearia chathamica*)

Miss Reynolds, photo

FIG. 53. Tete-a-weka (*Olearia angustifolia*), Stewart Island

W. Martin, photo

FIG. 54 Vegetable Sheep (*Haastia pulvinaris*) on summit Mt. Ferny Gair, Marlborough, at 5,000 feet altitude

drier hillsides of Nelson and Marlborough and of the North Island hills is that known as the NATIVE DAPHNE or TARANGA (*Pimelea longifolia*). It differs from other Pimeleas in the long, glabrous leaves, and larger heads of sweet-scented, white or rose-pink blossoms.

Another section of the shrubs is of great interest, not so much from their suitability for garden culture, but rather from the remarkable forms they assume in response to the inhospitable conditions that obtain in the places where they grow. Of such the more outstanding examples are the VEGETABLE SHEEP, the CORAL SHRUB, the STICK PLANT, and numerous divaricating shrubs of similar appearance yet belonging to the most diverse families.

The vegetable sheep are regarded as constituting one of nature's most remarkable plant productions. At least three species resemble the sheep both in size and colour, but the two best known and largest are *Haastia pulvinaris* and *Raoulia eximia*. The *Haastia* is restricted to Marlborough and eastern Nelson, but the *Raoulia*, which ranges from North Otago to Nelson at heights of four thousand feet and over, is nowhere more easily seen or more abundant than on Mt. Torlesse in Canterbury. Colonies of *Haastia* may often be clearly visible near the head of the shingle fans at distances of three to four miles and many a shepherd's dog has made a long journey for the purpose of mustering these immovable sheep. Large plants have been measured up to twelve feet across but half of this is normally a large 'sheep'. These shrubs have a semi-globular or mounded form with a continuous surface comprised solely of the leafy tips of hundreds of branches so densely compacted that it is scarcely possible to thrust one's fingers between them. Each leaf is covered with a thick coat of yellow tomentum, and each leafy tip

measures about half an inch across. Exposed as they are to fierce sunshine by day and acute frosts by night, to frequent gales and parching nor'westers, to arid soils and winter snows, these shrubs have developed a form which reduces transpiration to a minimum. *Raoulia eximia* is a greyer plant with narrower branches. The commoner vegetable sheep of Otago is intermediate in

J. S. Thomson, photo

FIG. 55. Vegetable Sheep (*Raoulia eximia*) on Mt. Torlesse, Canterbury

appearance between these two, and is known as *O. buchanani*. It is a smaller plant, which would never be mistaken for a sheep. The same remark applies to the vegetable sheep of Stewart Island (*R. goyeni*) a greenish, very rigid but small form which grows on Mt. Anglem, Table Hill, and Mt. Rakiahua. *R. rubra* of the Tararuas is the only North Island representative.

The STICK PLANT (*Corallospartium crassicaule*) is a leafless broom consisting of a single, more or less cylindrical but deeply-grooved stem with few short branches or even none at all, which bears dense clusters

J. S. Thomson, photo

FIG. 56. Vegetable Sheep (*Haastia pulvinaris*) growing in garden of the late J. Scott Thomson, Dunedin

of woolly flowers in the notches of the branchlets. The tallest specimens may attain the height of a man and the stem the thickness of one's finger, but normally these dimensions may be halved. Like the *Haastia* this belongs to an endemic genus. It occurs on shingly slopes on Otago and Canterbury mountains.

Several shrubby daisies belonging to the genus *Helichrysum* have closely appressed leaves and cylindrical stems, chief of which in interest and largest in size is the CORAL SHRUB (*H. coralloides*), a subalpine lithophyte from Marlborough. This shrub has thick green tubercled stems forming either a compact or open cushion according to the severity of the local conditions.

G. J. Helyar, photo

FIG. 57. Marlborough Rock Daisy (*Pachystegia insignis*)

It provides another example of those remarkable daisies that form so distinctive a feature of the New Zealand flora. Closely similar but smaller are the CAPE SAUNDERS ROCK DAISY of Otago Peninsula, and *H. selago* of Canterbury and Marlborough. Certain high-altitude species of *Hebe* likewise develop scale leaves, and as a group constitute the WHIPCORD VERONICAS.

Olearias and Senecios

Together these two daisy genera number over sixty species more than half of which are shrubs or small trees. We have already referred to several of the more floriferous members, but there are many others worthy of notice because of their abundance or striking appearance. A number which are usually shrubs may become quite sizable trees in certain situations while others regularly grow into trees up to twenty or thirty feet high. In all, over a dozen of our native daisies attain tree-like dimensions, if we include several growing only on the out-lying islands.

From the Chatham Island we have *Olearia traversii* and *Senecio huntii,* the former useful as a shelter tree in exposed situations in coastal areas, and the latter an ornamental tree which, in its flowering season, forms a yellow girdle round almost every forest remnant in the south of Chatham Island. It is grown extensively in Invercargill, being both hardy and easy to propagate. One specimen of the *Olearia* measured by the writer at Chatham Island had a girth near the base exceeding eight feet, though the tree was little more than twenty feet high. *O. lyallii,* on the Auckland Islands and the Snares may, according to Cheeseman, reach a height of thirty feet and have a base two feet in diameter. This tree has broad, densely tomentose leaves six to eight inches long. Branches and flowering stems have a dense covering of pure-white wool, and in its natural abode it is described as a magnificent plant, though it is still rare in cultivation.

The TUPARI (*O. colensoi*) is an allied plant forming extensive areas of subalpine and coastal scrub on Stewart Island, and ranging along the western side of the Alps and of the axial chain in the North Island, where it fringes the forests at the upper levels. One specimen

measured by the writer at Port Pegasus in Stewart Island had a bole fourteen inches in diameter. Only in such coastal stations in Stewart Island does it attain tree dimensions. So dense is the growth and so rigid are the branches that neither man nor dog can force a way through much of the tupari scrub. As a specimen shrub it is very effective, but it is a difficult subject and rarely seen in gardens. One form near Wilson Bay in

W. Martin, photo

FIG. 58. The Coral Shrub (*Helichrysum coralloides*) on rock at 5,000 feet altitude on Mt. B.J., Marlborough

the South of Stewart Island as a young plant had leaves almost a foot long and broad in proportion. Normally the leaves are deep green above, very rigid and coriaceous, with a polished upper surface and thick white tomentum on the under surface, and on the young shoots. The flowers however have no ray florets. Another daisy shrub growing in great abundance round the coasts of Stewart Island is that known as the LEATHERWOOD or MUTTONBIRD SCRUB (*S. puffini*), the leaves of which were at one time frequently used

J. S. Thomson, photo

FIG. 59. *Helichrysum coralloides* normally a rock plant of South Island mountains, in garden of the late J. Scott Thomson

as post-cards and despatched from the most southerly post office in the world situated on the island of Ulva, in Patersons Inlet. The practice was later prohibited and the post office disestablished. Normally a shrub six to eight feet high, this plant also on occasion could become a small tree twenty feet or more tall.

The NATIVE HOLLY, so called because of its holly-like leaves, is yet another indigenous daisy (*O. ilicifolia*) which on subalpine forest margins may attain tree dimensions with a trunk twelve to twenty inches through at the base. More usually it is a small bushy shrub, very hardy, and suitable for the garden shrubbery. It occurs as far north as East Cape and on the West Coast descends to sea-level. *O. fragrantissima,* normally a tortuous shrub, in Otago may become a woody tree with deliciously peach-scented but small, deciduous leaves borne on slender, zig-zag branches. It occurs on Banks Peninsula, Otago Peninsula, Saddle Hill, and Waipori Gorge but is comparatively rare. Yet another divaricating shrub daisy that has been known to develop into a twenty-five foot tree with a basal thickness of one foot is that known as *O. virgata.* This is a common species in all three islands from Thames southwards, which at a short distance could easily be mistaken for manuka, a resemblance even more closely observed in *O. lineata,* a twiggy shrub with more or less of a weeping habit that grows in North and Central Otago.

One of the most widely distributed species is *O. avicenniaefolia* with large, entire, pointed leaves and large panicles of white flowers which, however, have rarely more than one or two 'petals' and so lack any particular beauty. The common hedge plant, one of the best from many points of view, is *O. paniculata* often sold under the name *Olearia forsteri.* This is subject to the attack of a red-bodied gall-forming fly. The

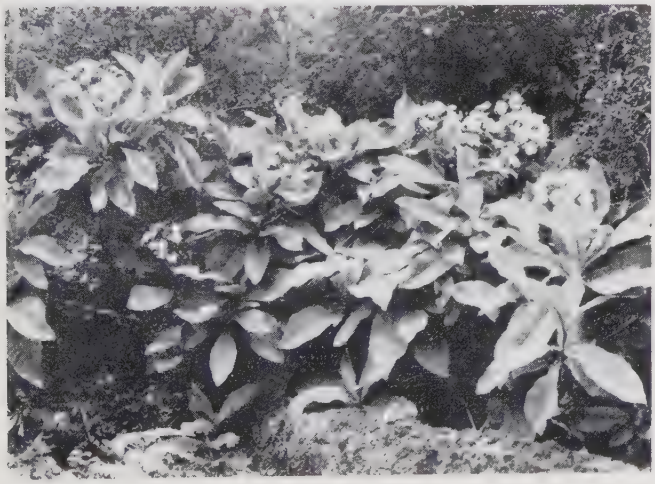
stout branching shrub or small subalpine tree known as *O. lacunosa* is easily recognised from its long linear leaves, rugose above, and rusty brown beneath, and commonly four to seven inches long. It grows on most of the western mountains of Westland, on the mountains of Nelson, and in the subalpine forests of the Tararua Mountains. In the lower forests from Nelson and Marlborough right to the North Cape the Heketara (*O. rani*)

Miss Reynolds, photo

FIG. 60. Glory of the Hills (*Olearia arborescens*), a common shrub of lowland hills and stream banks

is an abundant forest species best recognized by the buff tomentum of the stems and veined under surfaces of the leaves, and by the large panicles of white blossoms.

What is perhaps the most variable of all the shrub-daisies yet one easy to recognise from the general aspect, no less than from the satiny appearance of the undersides of the leaves, is that known as the 'hill glory' (*O. arborescens*). In summer its large panicles of pure white blossom are conspicuous in montane shrubberies anywhere south from East Cape to Stewart Island.



J. S. Thomson, photo

FIG. 61. Takaka Daisy Shrub (*Senecio hectori*), a white-flowering Senecio of special garden merit

With one or two exceptions *Senecios* have yellow flowers while no *Olearia* has other than white or purple florets unless it belongs to those sections completely devoid of ray florets. In general it is thus easy to

distinguish the two genera under discussion. Two of the most widely grown *Senecios* are *S. greyii* and *S. compactus,* both originating on the coastal cliffs of Wellington north from Lake Wairarapa. These have white stems and whitish or greyish-green leaves so that the whole bushy shrub might be described as white. During the summer months these are densely covered with yellow daisy blossoms about an inch in diameter. Both are easily propagated from cuttings. As a foliage shrub *S. bidwillii* is much favoured in gardens because of its hardiness, its dark-green, mottled leaves, and the brown tomentose tips of the branches and under surfaces of the leaves. It is a plant of the mountains of the central parts of the Dominion.

For all-round excellence, however, *Senecio hectori* from Western Nelson with its large tobacco-like leaves and white trusses of pure white daisy blossoms would usually be given the place of honour as the finest of the garden groundsels. *S. monroi* of Marlborough is also useful for the garden shrubbery.

The Coprosmas

New Zealand is the headquarters of the genus *Coprosma,* as more than half of the ninety-odd known species are restricted to this Dominion. They are related to both the coffee plant and to the dye-producing madder plant, but outside of New Zealand are found only in Australia and some of the tropical islands of the Pacific. All species have their leaves and branches in opposite pairs or fascicles, the larger leaves being commonly characterized by the presence of pits or domatia at the junction of the veins with the midrib. The flowers are usually unisexual and borne on separate plants. They lack petals and are never conspicuous,

but the female plants later develop drupes in great abundance, white, cream, yellow, pink, orange, red, blue or black according to the species, at which time many of these shrubs have a beauty that commands attention and admiration.

By courtesy L. W. McCaskill

FIG. 62. Karamu (*Coprosma robusta*)

A majority of the bushy shrubs with twiggy branches and small opposite leaves are Coprosmas, colloquially known as 'wiggy bushes' or 'miki-miks', this name being a corruption of the Southern Maori miki-miki. However, several species can become tall trees (e.g. *C. chathamica*) while others (e.g. *C. petriei*) are little more than trailing herbs. On Chatham Island

this tree attains a height of forty feet with a basal diameter of two feet, while *C. arborea* of North Auckland also forms a round-headed tree upwards of thirty feet bearing translucent white 'berries'.

Of the larger shrubby species the widely dispersed KARAMU (*C. robusta*) and the similar (*C. lucida*) are two of the best known. Both have reddish-orange opaque 'berries', but the latter may be distinguished by the more glossy leaves and by the three-branched fruiting stems. Both are plants of the forest margin or open shrubbery. An abundant forest species at all levels with a most obnoxious smell, especially when bruised, is the HUPIRO more usually and aptly termed STINKWOOD (*C. foetidissima*). This shrub occurs often in great abundance in subalpine forests of the North Island south from Coromandel Peninsula. In the South Island it is met with at all levels and in Stewart Island is the commonest species. It ranges south to the Auckland and Campbell Islands. Other common forest species include the red-berried *C. rubra, C. rotundifolia,* and *C. rhamnoides,* and the blue-berried *C. parviflora.*

One of the commonest of the shrubs that is found on open windswept localities is *C. crassifolia,* and of the swamp-dwellers *C. propinqua* and *C. rigida* are perhaps the most common. Of the many Coprosmas found in subalpine scrub one of the commonest is *C. pseudocuneata.* Though far from common, *C. virescens* is nevertheless widespread, growing both in the open and in open forest southwards from Hawkes Bay. It is commonly deciduous and normally is an erect shrub with interlacing divaricating branches.

Especially when clothed with translucent blue berries, the SAND COPROSMA (*C. acerosa*) forms a very pretty little divaricating but semi-prostrate shrub found on sandhills throughout the country. It is the only species

of the sandhills with a brownish colour, linear leaves, and blue fruits; but, in other places as on clay banks, a very similar but less divaricating plant known as *C. brunnea* is also common. The glossy leaved TAUPATA,

J. S. Thomson, photo

FIG. 63. *Hebe macrantha* in garden of the late J. Scott Thomson

so popular as a hedge plant in Wellington and other coastal towns is *C. repens*. Then on the western sides of the Alps and other South Island mountains there may be found the only species with serrated leaf margins, namely *C. serrulata*, a plant which is being greedily eaten out by deer and wapiti.

Hebe

Much the largest genus of the New Zealand flora is that formerly listed as *Veronica* but now known as *Hebe*. It is difficult to state the precise number of species as many, formerly deemed good species, are now known to be hybrids, while others comprised a

J. S. Thomson, photo

FIG. 64. *Hebe linifolia* from Otira Saddle in garden of late J. S. Thomson

mixture of forms that are slowly being disentangled; but it is clear that the number is not far short of a hundred, if indeed it is not even greater. These include over a dozen herbaceous species, the remainder being shrubs of varying size and appearance.

Half a dozen species have serrated leaves besides

which they are all attractive flowering plants. To this group belong the New Zealand lilac (*H. hulkeana*), the Campbell Island *H. benthamii* with flowers of deepest blue, the large-flowered *H. macrantha* of the Southern Alps easily observed near the Hermitage at Mt. Cook, the AKAROA SPEEDWELL (*H. lavaudiana*) now almost extinct, and *H. raoulii*, an allied plant of montane rocks in Canterbury and Marlborough, with red-rimmed leaves and pink flower-buds. *H. catarractae* in several forms is a choice garden subject with a long flowering season.

A beautiful little rock plant with flowers of purest white that grows in moist climates or situations on the western mountains of the South Island is that named *H. linifolia;* while the red-flowering *H. speciosa* of North Island coasts, now rare in the wild state, is abundant in gardens. Even the common KOROMIKO (*H. salicifolia*) in any of its numerous forms makes quite a suitable and hardy flowering shrub for garden culture. Indeed, there are few species that do not make suitable subjects for the garden or rockery.

There are not a few floriferous coastal Hebes, commonest of which is the COASTAL SPEEDWELL (*H. elliptica*) which becomes increasingly so as we travel from Mt. Egmont to Stewart Island or to Campbell Island further south. Indeed, it ranges to the southern shores of South America. Dr. Cockayne has drawn attention to its absence between Dunedin and Pelorus Sound; but, though far from common, it still persists at Katiki and near Moeraki and once grew near Timaru. In the North Island, two of several coastal speedwells are *H. macroura* and *H. cookiana* from the cliffs south from East Cape, both useful garden plants. Many alpine and subalpine species assume a ball-like habit of growth and all of these are suitable for the shrubbery.

J. S. Thomson, photo

FIG. 65. Common Koromiko (*Hebe salicifolia*), on Mt Watkin, Otago

Another section of this large genus comprises those commonly grouped as the WHIPCORD VERONICAS. These have scale-leaves only, so that the stems of several (e.g. *H. hectori*) are terete and cord-like, though more usually the stems are tetragonous or cupressoid. So closely do the branchlets of some of these plants resemble the branchlets of white pine, silver pine, and other taxads that Dr. Hooker the celebrated English botanist was about to describe a plant sent to him for identification as a pine, when he noticed a seed capsule and so was able to avoid a serious but pardonable mistake. Over a dozen species belong to this group. Two similar plants with leafy stems up to half an inch wide are found in shingle at high altitudes. The first (*H. epacridea*) has strongly keeled, recurved leaves on rigid stems less than a foot long. The other is greener and less rigid, has leaves without keels, is rather more erect, and grows in wetter climates. It is named *H. haastii* after Sir Julius von Haast. In all the Hebe species, the leaves are arranged in four rows which renders their recognition easy.

The Brooms

The horticultural excellence of the PINK BROOMS has already been referred to and also of the KAKA-BEAK or *Clianthus,* but taken as a whole the pea family is not well represented in this country, save by the genus *Carmichaelia,* nor are the majority of species such as to command admiration. Nevertheless the fifty odd species and varieties of *Carmichaelia,* and indeed all the other members of the pea family, are to be found nowhere else. Quite a majority save as seedlings are either leafless shrubs or leafless in winter, and according to the late George Simpson no South Island species is found in the North Island and vice versa.

Miss Reynolds, photo

FIG. 66. Koromiko (*Hebe salicifolia*), flower spikes and leaves

The more leafy species comprise *C. grandiflora* from the area south of Reefton to the Sounds of Otago and from the heads of the river valleys on the eastern side where the rainfall is high, *C. odorata* from the stream banks and forest margins of northern Hawkes Bay, and *C. glabrata* from the Pelorus Valley in Nelson.

The largest of these brooms is *C. williamsii* which, near East Cape and on one or two outlying islands, forms a small tree ten to twenty feet tall. The branches are broad and flat, the yellow flowers over an inch long, and the pods large and turgid. These features are not met with in any other species. Many of the South Island species are bushy little shrubs only an inch or two high and spreading by underground stems. Such are *C. orbiculata* and *C. enysii,* both plants of arid stations on Canterbury and Maniototo Plains. Larger still is a group of which *C. monroi* is a typical member. These have coarse flat stems rarely longer than one foot.

In Central Otago and other South Island localities there may be observed a bushy leafless shrub with yellow, cylindrical, almost spinous stems. This is *C. petriei.* Notwithstanding its wholly unappetising appearance, cattle are fond of chewing the stems. Another rather rare species has long rush-like stems devoid of leaves save in shade, which scramble through or over the nearby vegetation at New Brighton, Otepopo, and Cardrona Valley. Formerly this was known as *C. gracilis,* but it is now known as *C. kirkii.*

Of the other genera of native brooms we have already referred to the stick-plant of the subalpine screes, but in similar places (e.g. Mt. Ida) one occasionally meets a small pubescent herb with leaves similar to those of the kowhai, and a large inflated pod. This is the sole New Zealand member of the genus *Swainsona,* elsewhere Australian. One species of KOWHAI (*Edwardsia pros-*

W. Martin, photo

FIG. 67.—Typical divaricating shrubs on wind-swept hillside, Otago Peninsula.
The shrubs in the foreground are *Suttonia divaricata*, *Olearia lineariifolia*, *Corokia cotoneaster*

trata) restricted to Marlborough and Canterbury never advances past the stage of a divaricating shrub. It grows on exposed hillsides and often takes the form of a globular mound.

J. S. Thomson, photo

FIG. 68. New Zealand Daphne (*Pimelea aridula*) and *Celmisia verbascifolia* in garden of the late J. Scott Thomson

To the Daphne Family belong a score of shrubs belonging chiefly to the genus *Pimelea,* all endemic to this country. Much the largest and finest of these is the New Zealand Daphne or taranga (*P. longifolia*), a handsome shrub attaining a height of four or five feet on occasion, and in summer clothed with copious, white or rose-coloured fragrant blossoms. It does not range south of Nelson or Marlborough. *P. gnidia* is a smaller shrub, with much smaller leaves and flowers, but intermediate forms are sometimes hard to distinguish from

the taranga. *P. arenaria* is a low, silky shrub common on sand-dunes and *P. sericeo-villosa* is abundant on dry, arid soils of South Island uplands and especially in Central Otago and near Lake Wanaka.

The three species of *Drapetes* are all prostrate shrubs of small size, located in subalpine habitats, two being restricted to the South Island.

The Heaths and Epacrids

To enumerate or to describe the whole of the native shrubs is neither practicable nor necessary, yet there remain many which because of their abundance, their intrinsic interest, or their decorative merit deserve some notice. Outstanding among the more than forty species of heaths, true or false, is the TAUPO SNOWBERRY (*Gaultheria oppositifolia*), with its opposite sessile, bluntly notched leaves and pure white 'lily of the valley' flowers. This shrub is abundant in the southern half of the Auckland Province. *G. rupestris* is a smaller shrub with alternate leaves and beautiful white racemes which is quite common in subalpine scrub from Thames to the south of Otago. The most common member found on the forest margin or in lowland shrubberies is *G. antipoda*. There occurs in all three islands south of Lake Taupo a more or less prostrate heath now named *Pernettya macrostigma* which has slender interlacing branches, small, narrow, toothed leaves, and either white or red berry-like fruits. This is most commonly seen in boggy soils. The SNOWBERRY (*G. depressa*) is distinguished by its shorter stems and broader leaves, though the fruits are similar but larger and highly decorative.

The following heath-like plants are known as Epacrids. The MINGI-MINGI (*Cyathodes acerosa*) is a pungent-leafed, erect shrub common in heaths on the driest

hillsides, which like the snowberry has fruits that may be white, pink, or red. A very common associate, though occurring also in the forest, is a larger mingi-mingi (*Leucopogon fasciculatus*) which has tiny white 'berries' and small linear leaves without the sharp tips. The PATOTARA (*L. fraseri*) is a dwarf, bronze-coloured, pungent-leafed, golden-fruited epacrid only a few inches high common in heaths and on grassy uplands throughout New Zealand.

Reference has already been made to several arborescent heaths of the genus *Dracophyllum,* but most of the species of this genus are erect-growing or rock-frequenting shrubs without any great horticultural excellence. There is one species, however, of very distinctive appearance that abounds in the Fiord region of Otago (e.g. near Homer Tunnel) and on Mt. Anglem in Stewart Island known as *D. menziesii.* This might be described as a miniature of the MOUNTAIN MOP or NEI-NEI (*D. traversii*). Though rarely more than four feet high it is a most distinctive and striking plant with the largest flowers of any species. The stems are devoid of leaves save at the tip. The outer leaves are recurved, broad at the base and tapering to a sharp point, of a reddish colour, and six to eight inches long.

Two species of *Epacris* range north from Westport. Both are plants of barren clay or peaty soils but are quite floriferous and attractive shrubs.

Other Shrubs

There are several fine shrubs from the Auckland Province that would grace any garden. In this group we would include the KOROKIA-TARANGA (*Corokia buddleoides*), the MAIREHAU (*Phlebalium nudum*), and KUMARAHOU (*Pomoderris elliptica*). The *Corokia* is a choice shrub at all stages of its growth, and quite hardy

in all parts of the country. The leaves are silvery white on the lower surface, the flowers are bright yellow and star-like, and the berries dark red. *C. macrocarpa* from Chatham Island has larger leaves and orange berries, but is very similar and equally worthy of cultivation; while the smaller leafed *C. cotoneaster* is a most attractive shrub, ranging over most of the upland in the shade of other shrubs, and displaying in the summer similar yellow, starry blossoms which give rise later to conspicuous yellow, orange, or red berries.

The mairehau is the sole New Zealand species of an Australian genus famed for the fragrance of its leaves and pure white flowers, as is the yellow-flowered kumarahou (*Pomaderris elliptica*) for its striking and ornamental appearance during the summer months. Much less attractive is the smaller TAUHINU (*P. phylicaefolia*), a heath-like shrub common in open country in the North Island, and also on the Canterbury Plains near Ashburton. The TAINUI (*P. apetala*) is quite a pleasing plant which according to Maori legend originated from the skids brought in the ancestral canoe of that name.

In North Island forests the MATATA is a common shrub distinguished at once by its handsome red-striped, pendulous, orange blossoms. It is a relation of the greenhouse *Gloxinia* and known to botanists as *Rhabdothamnus Solandri.*

Amongst the shrubs that do not grow naturally in the southern part of the South Island we may note the WHARANGI (*Melicope ternata*), the PEPPER (*Macropiper excelsum*), the HANGE-HANGE (*Geniostoma ligustrifolium*), the RANGIORA and the PUKAPUKA, the RAMARAMA (*Myrtus bullata*), and others less common. The Wharangi is a glossy green relative of the orange and lemon, and like these plants has a conspicuous

Miss Reynolds, photo

FIG. 69. Tainui (*Pomaderris apetala*), almost a small tree

joint separating the blade of the leaf from the stalk; but, like the Mairehau to which it is also related, it bears fruit quite unlike those of the citrus plants. The leaves are ternate and placed in opposite pairs. The only other species (*M. simplex*) ranges over both the main islands on the forest margin or in scrub, but fails to cross into Stewart Island. This is a divaricating shrub with simple, jointed leaves not unlike those of the ANOMALOUS PANAX (*Nothopanax anomalum*) which rarely exceed half an inch in length.

Many of the shrubs that frequent open, exposed hillsides especially of the South Island show a most striking convergence of form and habit in keeping with their conditions of life, notwithstanding the fact that they belong to diverse families. Such would include the divaricating shrubs *Muehlenbeckia astoni* (dock family), *Melicytus micranthus* (violet family), *Melicope simplex* (orange family), *Nothopanax anomalum* (ivy family), *Olearia fragrantissima* (daisy family), *Coprosma crassifolia* (coffee family), *Pennantia corymbosa* (Icacina family), and *Corokia cotoneaster* (broadleaf family). All are bushy shrubs, with tough interlacing branches, small leaves, and compact habit. Only by a close examination can they be distinguished. Some later pass to an adult form, when recognition becomes easy.

Much the finest of three Myrtles is *Myrtus bullata* well known as the RAMARAMA. This has reddish, 'blistered' leaves unlike those of any other native shrub. The ROHUTU (*M. obcordata*) is more widespread and has small leaves with an apical notch, while *M. pedunculata,* the third species, is recognised at once by the small leaves lacking this notch at the top.

Subalpine shrubs worthy of note include the ROCK MAHOE (*Hymenanthera alpina*), the MOUNTAIN WINE-

W. Martin, photo

FIG. 70 Ball-like shrubs of the dwarf Kowhai (*Edwardsia prostrata*) on hills near L. Grassmere, Marlborough

BERRY (*Aristotelia fruticosa*), the ALPINE BLUEBERRY (*Suttonia nummularia*), and an Exocarpus. The first is a most rigid, thick-stemmed shrub of the violet family which commonly lies prostrate on a rock. The stems are frequently spinose at the tips and devoid of leaves on all exposed parts. The berries are bright blue or violet where facing the light but white on the shaded parts. The wineberry is a small-leafed shrub which also becomes somewhat spinous when in exposed positions. The blueberry is one of four shrubby species of *Suttonia* of which the mapou is an arborescent member, and is a small bronze-leafed more or less prostrate shrub with pretty blue berries. The WEEPING MAPLE (*S. divaricata*) is at once the commonest and best known of the *Suttonia* shrubs, occurring as it does throughout New Zealand usually, but by no means invariably, at the higher levels. It is a tall shrub or even a small tree with divaricating, interlocking branches which tend to droop near the tips imparting to the plant the aspect of a weeping shrub. The leaves are small and glandular and the berries small and violet in colour.

Several of the matipos (*Pittosporum*) are likewise divaricating shrubs of subalpine forests and shrubberies, *P. rugosa* being a particularly rigid shrub. Several are rather rare (e.g. *P. obcordatum*), but whatever their form they can be recognised at once when in fruit, for the capsules on opening display several black seeds embedded in an orange jelly.

One of the commonest shrubs on the open plains or on shingly riverbeds is that variously known as the MATAGOURI, TUMATAKURA or WILD IRISHMAN (*Discaria toumatou*). This is a spinous dark green shrub which in sheltered stations may attain a height of fifteen feet, though normally it is less than half of this.

Few shrubs are able to thrive with their roots in brackish water but one such is the SHORE RIBBONWOOD (*Plagianthus divaricatus*), a bushy shrub with small leaves or occasionally none at all which may be seen wherever there is a tidal inlet or estuary. The only other shrub that can grow in a similar situation is the mangrove so abundant on mud flats in tidal estuaries north of Thames. This shrub or small tree has the roots submerged daily; so to assist in its metabolism it thrusts numerous finger-like aerial roots above the water. It is remarkable also in that the seeds germinate before the capsules fall off the plant into the water. It is related both to the teak and the puriri as well as to the *Lantana, Verbena,* and to the endemic *Teucridium parvifolium,* a twiggy shrub nowhere common, but widely dispersed on forest margins in lowland districts of both islands.

In conclusion, we may mention two daisy genera with shrubby representatives. The first is the rangiora (*Brachyglottis rangiora*) which differs very little from the more widespread *B. repanda* of which it seems little more than a trivial variety. These shrubs have leaves up to twelve inches long by six to eight inches wide, well known for their ability to poison stock. Both range north from Greymouth and Kaikoura, the former to Wellington and the latter to the North Cape. The other genus is *Raoulia* to which various vegetable sheep belong. There are, however, several species which form extensive patches, prostrate instead of hemispherical, and of these none is more common than the scabweed which, particularly in Central Otago, covers extensive areas of barren and depleted soils with circular patches up to a yard in diameter. This is *R. lutescens,* largest of a group of similar patch plants that appear perhaps more herbaceous than shrubby. *R. australis* is easily confused with the scabweed but has

larger flowers without the bright yellow involucre of that species, while *R. haastii* forms compact green or bronze cushions of slightly mounded form. A common associate of the scabweed is a furry little *Pimelea* (*P. sericeo-villosa*) very abundant at and near Wanaka in Otago.

Key to Identification of New Zealand Shrubs

With a view to assisting the reader to identify the New Zealand shrubs, the following table has been drawn up, which, by grouping together all shrubs having certain characteristics in common, serves to narrow down the range of possibilities to a list of small dimensions. The final identification in many cases will require reference to such a standard Flora as Cheeseman's *Manual of the New Zealand Flora,* or to such a detailed key as is supplied in Dr. Allan's *New Zealand Trees and Shrubs;* but it is thought that in numerous cases this final step will scarcely be necessary or will at least be greatly simplified.

The first step in making the identification is to note whether the branchlets or leaves grow singly or in pairs, then to note whether the margin is entire or in any way notched, lobed, or dissected. Reference to the average size of the leaf and to whether the leaf is blunt or sharp-pointed will further serve to limit the possible identifications. Column 2 gives at least one popular name.

The figures in column 3 serve to indicate the districts in which the shrub grows in its natural state. Each Island is divided into five by equidistant lines drawn from east to west, and these areas are then numbered from north to south. Any person interested in distribution will find a more natural classification of botanical districts in Dr. Cockayne's charming book, *New Zealand Plants and Their Story.*

The notes in column 4 provide additional information of use in distinguishing the members of any group. In genera containing numerous species, such for example as Hebe (*Veronica*), Coprosma, Olearia, Senecio, no attempt has been made to distinguish the whole of the individual species.

KEY TO NEW ZEALAND SHRUBS

A. STEMS (AND LEAVES) IN OPPOSITE PAIRS

I. MARGINS OF LEAVES NOTCHED OR LOBED

(a) *Leaves usually not less than one inch long*

Gaultheria oppositifolia	Niniwa *or* Tarawera Snowberry	3	Leaves sessile, 500 ft.-3500 ft.
Hebe hulkeana	N.Z. Lilac	6-7	On rocks
Coprosma serrulata	Notch-leafed Karamu	6-10	2000-5000 ft.
Rhabdothamnus solandri	Forest Abutilon	1-5	Tubular dull red flowers

(b) *Leaves usually less than one inch long*

Aristotelia fruticosa	Mountain Currant	3-10	1000-4500 ft.
Hebe raoulii	Native Lilac	6-7	500-3500 ft.
Hebe lavaudiana	Lavaud's Speedwell	8	Akaroa hill-tops
Hebe macrantha	Mount Cook Speedwell	6-9	2500-5000 ft., large white flowers

II. MARGINS OF LEAVES ENTIRE (sometimes waved)

(a) *Leaves usually not less than one inch long*

Coprosma spp.	Karamu	1-10	Translucent berries; pits at fork of veins and midrib
Coriaria spp.	Tutu (toot)	1-10	Leaves sessile, stems often in threes
Hebe 30 spp.	Koromiko	1-10	Mostly lowland forms
Pimelea longifolia	Maori Daphne *or* Taranga	3-6	Glabrous; flowers white and rose
Geniostoma ligustrifolium	Hange-hange, N.Z. Privet	1-6	Leaves broad, pointed
Avicennia officinalis	Mangrove	1-3	Grows only on saline mud
Myrtus bullata	Rama-rama	1-6	Leaves reddish-brown, blistered
Olearia hectori	Deciduous Tree-daisy	6-10	Deciduous
Olearia lineata	Needle-leaved Daisy Tree	9-10	Open, graceful habit

(b) *Leaves usually less than one inch long*

Coprosma spp.	Miki-miki	1-10	Leaves often pitted on the back
Coriaria thymifolia	Thyme-leaved Tutu	3-10	Leaves quarter to one inch
Coriaria angustifolia	Fine-leaved Tutu	3-10	Leaves less than quarter inch
Discaria toumatou	Wild Irishman	3-10	Spiny, stony ground
Hebe 30 spp.	Veronica, Speedwell	1-10	Leaves in four distinct rows
Hebe 17 spp.	Whipcord Veronicas	6-10	Alpine, scale leaves
Hebe astoni	Whipcord Veronica	4	4000-5000 ft.
Hebe tetragona	Whipcord Veronica	5	2000-5500 ft.
Pimelea 14 spp.	Pimelea	1-10	Not unlike Hebe
Myrtus obcordata	Myrtle	2-10	Top of leaf notched
Myrtus pedunculata	Rohutu	1-10	No notch in leaf
Teucridium parvifolium	Native Verbena	2-9	Blade and stalk of same length
Olearia 5 spp.	Olearia	3-10	Shrub daisies

B. STEMS (AND LEAVES) ALTERNATE, NOT IN OPPOSITE PAIRS

I. MARGINS OF LEAVES NOTCHED OR LOBED

(a) *Leaves usually not less than one inch long*

Alseuosmia 4 spp.	Alseuosmia	2 sp. 1-6 2 sp. 1-2	In woods; crimson or yellowish green tubular flowers
Nothopanax lineare	Narrow-leaved Panax	6-10	2500-4500 ft.
Hibiscus 2 spp.	Native Hibiscus	1	Yellow, dark-centred flowers
Phebalium nudum	Mairehau	1-2	Leaves slightly crenulate
Olearia 7 spp.	Various	3-10	Heads large
Olearia 5 spp.	Olearia	1-10	Heads small
Senecio 11 spp.	Senecio	1-10	Yellow-flowered daisy shrub
Solanum aviculare	Poroporo (Bullibull)	1-10	Flowers blue, fruit yellow
Traversia baccharoides	Traversia	6-7	1500-4500 ft., viscous

(b) *Leaves usually less than one inch long*

Nothopanax anomalum	Shrub Panax	1-10	Leaflets jointed to petiole
Gaultheria 4 spp.	Snowberry	1-10	Berries white or pink; flowers like Lily of the Valley
Melicytus micranthus	Manakura	1-10	Stiff rigid habit
Pernettya nana	Pernettya	8-10	2000-5000 ft.; creeping, matted heath

II. MARGINS OF LEAVES ENTIRE (sometimes waved)

(a) *Tip of Leaf acute or sharp-pointed*

i. Leaf usually not less than one inch long

Archeria racemosa	North Island Archeria	2-3	Erect, much-branched shrub
Dracophyllum 14 spp.	Grass-trees *or* Heaths	1-10	Leaves grassy, sheaths broad, leaf-scars prominent
Corokia buddleoides	Korokio-taranga	1-3	Flowers yellow, starlike, leaves green above, white below
Pittosporum pimeleoides	Slender-matipo	1	Flowers orange; habit slender

ii. Leaves usually less than one inch long

Archeria traversii	South Island Archeria	6-10	Branches numerous spreading, leaves small, flowers red
Cyathodes acerosa	Mingi-mingi	1-10	Leaves pungent, berries red or white; Shrub three to four feet high
Cyathodes 3 spp.	Dwarf Heaths	3-10	Usually 1000-5000 ft.
Dracophyllum 3 spp.	Mountain Heaths	3-10	White tubular flowers, solitary in 4 spp. 300-6000 ft.
Epacris pauciflora	Bog Heath	1-6	Erect, rigid, grows in bogs and on dry clay soils
Epacris alpina	Alpine Epacris *or* Nehe-nehe	3-8	Twiggy, leafy shrub heath
Leptospermum ericoides	Tea-tree *or* Kanuka	1-10	Small flowers, growing in clusters
Leptospermum scoparium	Manuka	1-10	Large flowers growing singly
Leucopogon fraseri	Patotara, Bronze Heath	1-10	2-6 in. high; leaves sharp pointed close-set, flowers heath-like
Leucopogon fasciculatus	Tall mingi-mingi	1-7	5-15 ft. high, leaves usually needle-shaped or lanceolate, flowers 6-12 in. drooping spikes

(b) *Leaves compound (or compound when present)*

i. Leaflets many

Clianthus puniceus	Kaka-beak	3	Large red flowers; 3-6 ft.
Edwardsia prostrata	Shrub-kowhai	6-8	Divaricating stems; 3-6 ft. yellow flowers

ii. Leaflets 3

Corallospartium crassicaule	Coral Broom	8-10	Leafless, erect; few branches, 2000-5000 ft.
Carmichaelia 21 spp.	Native Broom	1-10	Mostly leafless shrubs with small pods
Chordospartium stevensoni	N.Z. Wistaria Weeping Broom	6-7	Leafless, pods single-seeded, small
Notospartium 3 spp.	Pink Broom, etc.	6-8	Leafless brooms
Melicope simplex (juvenile only)	Poataniwha	1-10	Adult plants have simple leaves with blade jointed to leaf-stalk

C. TIPS OF LEAVES BLUNT OR ROUNDED

I. LEAVES USUALLY NOT LESS THAN 1 INCH LONG

(a) *Shrub-daisies*

Olearia 15 spp.	Shrub-daisies, Olearia	1-10	Seeds with pappus of hairs; flowers never yellow
Senecio spp.	Shrub Groundsels	1-10	Yellow or white flowers
Pachystegia insignis	Marlborough Rock Daisy	6-7	Very large white flowers, leaves thick, large
Olearia paniculata	(Olearia forsteri)	3-8	Common Ake-Ake or hedge plant

(b) *Shrubs other than shrub-daisies*

Dodonea viscosa	Ake-ake	1-7	Sea coast only, fruits winged
Pseudo-wintera axillaris	Horopito	1-7	In bush, leaves green below
Pseudo-wintera colorata	Pepper Tree	4-10	Leaves blistered, bluish beneath
Macropiper excelsum	Kawa-kawa	1-7	Leaves large, thin, cordate
Pittosporum kirkii	Kirk's Matipo	1-4	Epiphytic; leaves over two and a half inches long as rule
Pittosporum cornifolium	Perching Matipo	1-7	Epiphytic; leaves less than two and a half inches long as rule
Pomaderris apetala	Tainui	1-4	Tomentose shrubs
Pomaderris elliptica	Kumarahou	1-3	Tomentose; yellow-flowered
Suttonia montana	Large-leafed Weeping Maple	4-6	Stems red-brown, glabrous

II. LEAVES USUALLY LESS THAN 1 INCH LONG

(a) *Shrub-daisies*

Cassinia retorta	Tauhinu	1-3	White leaves
Cassinia leptophylla	Cottonwood	3-7	Also called Tauhinu
Cassinia vauvilliersii	Scented Cottonwood	3-10	Honey scented
Cassinia fulvida	Golden Cottonwood	3-10	Plant golden yellow
Helichrysum coralloides	Coral Daisy	6	Stems tubercled, one-third inch thick, 3000-5000 ft.
Helichrysum selago	Rock Everlasting	6-9	2000-4500 ft., sea level at Otago Peninsula
Helichrysum microphylla	Slender Rock Everlasting	6-7	Much and slender branched, 1500-4000 ft., florets yellow
Helichrysum depressum	Prostrate Everlasting	4-10	Grey and dead looking; grows on shingle
Helichrysum glomeratum	Cotton Ball	1-10	Leaves orbicular; petiole slender, galls frequent
Senecio cassinioides	Small-leaved Senecio	6-10	2400-4000 ft.
Olearia 4 spp.	Shrub-daisies	3-10	1500-4500 ft.
Olearia coriacea	Leather-leaf	6-7	Leaves wrinkled and rigid

(b) *Shrubs other than Shrub-daisies*

Pomaderris edgerleyi	Kumarahou	1	Tomentose straggling shrub; 2-4 ft.
Pomaderris phylicaefolia	Tauhinu	1-8	A heath-like shrub, 1-4 ft.
Corokia cotoneaster	Corokia	1-10	Leaves petiolate, blade round, flowers yellow, starlike
Suttonia divaricata	Weeping Matipo	1-10	Stiff, wiry, drooping stems
Suttonia nummularifolia	Creeping Mapau	4-6	Berries blue, like a snowberry
Melicope simplex	Poataniwha	1-10	Blade jointed to stalk
Muehlenbeckia astoni	Shrubby Pohuehue	5-6	Erect, divaricating, bushy shrub, petiolate leaves
Pittosporum rigidum	Mountain Matipo	3-6	2000-4000 ft., leaves entire or lobed, dentate, or pinnate
Pittosporum divaricatum	Mountain Matipo	4-10	500-3500 ft., branches thick, rigid, flexuose, interlacing
Drimys traversii	Small-leaved Horopito	6	2000-3000 ft., confined to Nelson Province
Plagianthus divaricatus	Shore Ribbonwood	1-10	Grows on edge of tidal estuaries, lagoons, and rivers
Hymenanthera 5 spp.	Hymenanthera	1-10	Leaves thick, obovate, glandular, stems with prominent lenticels

CHAPTER XII

HERBACEOUS PLANTS

THE AVERAGE NEW ZEALANDER knows little of the marvellous wealth of choice herbaceous plants that adorn the subalpine rock-gardens for which the mountains, particularly of the South Island, are famous. Here we meet with the finest buttercups on earth—white, cream, and yellow—some with leaves a foot and more across, surmounted on occasion by great trusses of from a dozen to as many as forty blossoms of purest white each three inches in diameter, and borne on flower-stalks one to four feet high. Here, too, are the mountain daisies or celmisias, some sixty in number, pure New Zealanders, and the chief glory of our alpine herb-fields. Charming ourisias, dainty eyebrights, lavender speedwells, strange forget-me-nots, handsome spear-grasses (*Aciphylla*), beautiful willow-herbs (*Epilobium*), and the extremely variable gentians, once seen in their profusion, especially in the extensive natural rockeries of the mountains of Otago and Canterbury, combine to create an unforgettable and vivid impression. Unhappily deer are rapidly depleting these alpine gardens, and over wide areas their glory has already departed.

No less remarkable are several of the herbaceous inhabitants of the outlying islands. The truly magnificent CHATHAM ISLAND LILY (*Myosotidium*), a lily so-called, but in truth prince of forget-me-nots, bears large, ribbed, rhubarb-like leaves, surmounted in season by massive trusses of white blue-centred blossoms. Very notable

also is the GIANT THISTLE (*Sonchus grandifolius*) from the same quarter. PLEUROPHYLLUM, a striking purple-flowered daisy, inhabiting the Auckland and Campbell Islands, is yet another of the plant aristocracy, remarkable for the corrugated leaves upwards of three and even four feet long. THE PUNUI (*Stilbocarpa*), an araliad with circular leaves measuring on occasion two feet across, which occupies the same territory as well as

Miss Reynolds, photo

FIG. 71. Mabel Island Lily, or Renga Lily (*Arthropodium cirrhatum*)

the coast of Stewart Island, like the former plant, has no near living relations, while *Chrysobactron rossii,* also from the same area, throws up massive spikes of brightest yellow, and by some observers this is regarded as one of our most conspicuous and attractive plants.

Hooker, the great English botanist, speaking of those lonely southern islands, says that he knows no other island anywhere that can boast of three such beautiful endemic plants as this CAMPBELL ISLAND LILY (*Chrysobactron*), the PURPLE-CENTRED CELMISIA (*C. vernicosa*), and the handsome GOBLET ASTER (*Pleurophyllum speciosum*). Notwithstanding this statement, yet another plant of this region, the blue-flowering coastal SOUTHERN FORGET-ME-NOT (*Myosotis capitata*), has been described as the most beautiful plant in the New Zealand flora.

Now, to review the whole of the herbaceous plants native to this country would occupy more space than we can devote to the purpose. Nor does it appear that any useful purpose would be served, for a very large number are inconspicuous and of small importance either for economic or ornamental purposes.

It is well known that a very large number of our plants are not only restricted in their distribution but circumscribed in respect to their habitats. Many are wholly confined to coastal stations, others to the forest interior, subalpine scrub, mountain meadow or herb-field, bog, or swamp. Of course coastal plants are sometimes plants of unstable sand dunes, of cliff faces, of coastal shingle banks, or of tidal inlets, and many are to be sought only in one of these stations. Similarly, lowland, subalpine, and high mountain plants are very often limited to one or other of these zones; yet within each zone the plants may be restricted to bog, to shingle scree, to rock crevice, to stream margin, etc.

It would be very desirable to consider the plants of each zone. Only in a very general way will this be attempted, however, because it seems preferable to consider some of the larger genera such as the buttercups and daisies as separate groups notwithstanding that each has species restricted to one or other of the most diverse habitats.

Coastal Herbs

Approximately a hundred herbaceous and semi-woody plants are either wholly or predominantly coastal, each in its own appropriate station. Grasses, rushes and sedges having been referred to separately, these will not, save in a few instances, be further referred to. Commencing with tidal inlets and lagoons we find flowering plants perpetually submerged, others submerged only at high tide, others on land subject to inundation only at spring tides, and finally a series of concentric zones of vegetation as the land becomes less saline and drier.

Perpetually submerged plants of calm salt water lagoons are mainly *Ruppia spiralis* whose ripening fruits are borne up to the surface on slender spirally coiled stems, and *Zanichellia* with sessile flowers and fruits. On the sandy or muddy soils between mid-tide and low-tide levels of tidal inlets and harbours, it commonly happens that large areas are covered by the grass-like, green leaves of the so-called SEA-GRASS (*Zostera*) used by the B.B.C. for sound-proofing purposes, all lying prone on the exposed surface at low tide. These three plants and the next all belong to the same family of flowering plants. The fourth member known as the arrow-grass (*Triglochin striata*) also grows on saline soils but always above high-water mark. This herb has more or less cylindrical leaves and an erect

flowering spike six inches or more high with small globular, sessile fruits crowded all along the upper half.

Tidal inlets are usually bordered on the landward side by a series of concentric zones of vegetation of a width depending on the slope of the ground. The first zone is usually occupied by the glasswort (*Salicornia australis*) a reddish, jointed succulent without apparent leaves and related to the fathen. With it or on its landward margin may be found the SALTWEED (*Selliera radicans*) and the MARSH PIMPERNEL (*Samolus repens*), two rather similar plants with fleshy leaves and creeping rhizomes but distinguished when in flower by the regular white flowers of the *Samolus* and the irregular flowers of the saltweed. Less commonly the succulent SEA-BLITE (*Suaeda maritima*) may be present also.

On slightly drier ground two species of *Apium*, a relative of the celery, may be noted frequently in association with two weeds much used for bowling green playing surfaces, namely *Cotula dioica* or one of its near relatives, and the STARWEED (*Plantago triandra*). Where a fresh-water stream meanders through the saltmarsh one may expect to see considerable breadths of the BACHELOR'S BUTTON (*Cotula coronopifolia*), a robust succulent with conspicuous bright yellow rayless flowers about a fifth of an inch wide. In just such places but commonly on the margin of the stream itself grows the NEW ZEALAND MUSK (*Mimulus repens*), a leafy herb with lilac-tinted flowers internally yellow.

As we move away from the water's edge on some sandy beach we may come on a plant of the ORACHE (*Atriplex crystallina*), a succulent herb of the fathen family everywhere dotted with glistening watery papillae, or in still more stable but moist sand the CREEPING

SAND SEDGE (*Carex pumila*). On the dune itself where the sand is quite unstable the *Pingao,* an orange-tinted sedge or, in the North Island, the spiny *Spinifex* are useful sand-binders in places not overgrown with the imported marram and lyme grasses or with the yellow sand lupin. Should the sand have just a trace of peaty soil mixed with it, a small buttercup (*Ranunculus acaulis*) may lie buried with only its ternate glossy leaves, burnished like polished greenstone, or solitary yellow flowers resting on the surface. Further consolidation of the sand is followed by the SAND CONVOLVULUS (*Calystegia soldanella*) with large flowers striped alternately white and pink or purple, and a numerous assemblage of other plants including rushes, sedges, grasses, toetoe, phormium, and sometimes the CABBAGE-TREE (*Cordyline australis*).

Coastal banks and cliffs also have their special vegetation, some not seen elsewhere. Here grow the tall bluish SEA-SPURGE (*Euphorbia glauca*), the NEW ZEALAND SPINACH (*Tetragonia expansa*), its red-berried congener (*T. trigyna*), and north of Banks Peninsula the related *Rhagodia nutans* also with red berries but of very small size. The coastal spleenwort and two species of hardfern (*Blechnum durum* and *B. banksii*) like the COASTAL SOW-THISTLE (*Sonchus oleraceus*) and the shrubby *Hebe elliptica,* are not found elsewhere.

The true flax is represented by *Linum monogynum,* an erect herb with large white flowers related to the plant from which linseed is obtained. Bare clay banks free from other vegetation commonly have sheets of the pink-flowered ICEPLANT or PIG'S-FACE (*Disphyma australe*) and sometimes of the COASTAL CHICKWEED (*Spergularia marginata*), both with succulent leaves, the former three-angled. Peaty banks north from Queen Charlotte Sound are commonly covered by

numerous plants of the charming RENGA LILY (*Arthropodium cirrhatum*) known also as the MABEL ISLAND LILY, a broad-leafed grassy plant with beautiful floriferous panicles and very suitable for garden culture.

Of plants with a more restricted distribution, one of the choicest is the red-flowered iris-like *Xeronema* from islands on the east of Auckland Peninsula. This is rapidly gaining popularity as a garden subject. Many species of *Celmisia* adorn the coastal cliffs, while the SHORE GENTIAN (*G. saxosa*), SNOWY EYEBRIGHT (*Euphrasia repens*), and the reddish succulent STONECROP (*Crassula moschata*) are well-known coastal plants of the Southland coast. Two inland plants common on the Wellington coastal banks are the MOUNTAIN FLAX (*Phormium colensoi*) and the SPEARGRASS (*Aciphylla squarrosa*).

Forest Herbs

This element of the flora is by no means an important one, the commonest members being several rather prosaic grasses and sedges, several lilies, orchids, and pennyworts, three species of *Nertera,* a white-flowered violet, a shamrock, and one or two lesser-known herbs such as *Australina* and *Parietaria*. Grasses, sedges, and epiphytic orchids are referred to elsewhere. Lilies are represented by two perching *Astelias* and two ground-dwellers, these being the tall KAURI-GRASS (*A. trinervia*) of kauri forests and the common BUSH-FLAX (*A. nervosa*), by the FOREST SNOWBERRY (*Enargea parviflora*), and by the BLUEBERRY (*Dianella*). The snowberry has both attractive white flowers and white berries borne on trailing stems bearing small oblong leaves with five or seven conspicuous nerves. The blueberry is a much larger tufted herb with long grassy leaves over half an inch wide, with rather insignificant

flowers, but with spreading panicles of large bright blue pendulous berries which serve to make this lily one of the more arresting of the herbs that frequent the forest-margins.

What may safely be regarded as one of the showiest of all forest herbs is *Colensoa physaloides,* a tall, thin-leafed herb confined to the most northern forests, and belonging to the same family as the bluebell and lobelia. The large pale blue flowers up to two inches in diameter borne in terminal racemes of a dozen or more give this plant considerable horticultural merit as do the succeeding blue berries. In places free from frost this plant grows well and easily in any shaded station. Another herb with most attractive foliage is the PARATANIWHA or so-called NATIVE BEGONIA (*Elatostema rugosum*), though it is in no way related to the begonia, being in fact a relative of the nettle. However, the leaves strongly resemble those of some forms of begonia being bronze in colour, alternate and pinnate, up to ten inches long, with margins of unequal length. It is a shade-loving herb covering dripping banks in northern forests as far south as Titirangi near Palmerston North. The nettle itself (*Urtica ferox*) is common enough in open forests especially near the coast and, though armed with copious stinging hairs, is not unattractive. It is the sole food plant of both the red admiral and yellow admiral butterflies.

Of the smaller herbs four (possibly five) species of *Nertera* are abundant forest herbs that drape rotting logs and sometimes carpet forest soils also, the largest being *N. dichondraefolia* with hairy leaves over half an inch long. The other species are not confined to forest and are most attractive when covered with their tiny bright red berries, often so numerous as to conceal the leafy carpet below. The commonest species are *N.*

depressa with glabrous leaves and *N. setulosa* with leaves covered with short stiff hairs but *N. balfourii*, when concealed by a carpet of orange or red obconic fruits, is the most attractive.

J. S. Thomson, photo

FIG. 72. New Zealand Nettle (*Urtica ferox*), Mt. Watkin, Otago

PENNYWORTS (*Hydrocotyle*) of many species are slender creeping herbs of shady forest soils with circular leaves less than an inch across, and are relatives of the carrot and parsnip. Many of these, however, are not confined to forest, being equally common on lawns and moist soils generally. The FOREST IRIS (*Libertia pulchella*) is a common occupant of mossy upland forests, being a slender grassy herb only a few inches high with a few white flowers in season. A much larger

species with leaves often more than two feet long (*L. grandiflora*) is a lowland plant of forest margins quite attractive when in flower or fruit. Each flower has three conspicuous white petals and each fruit is a large yellow capsule that ultimately bursts open into three segments to liberate the seeds. The creeping WHITE VIOLET (*Viola filicaule*) and the common WOOD-SORREL (*Oxalis lactea*) are further common ground herbs of subalpine forests, both with characteristic white flowers.

W. Martin, photo

FIG. 73. Chatham Island 'Lily' (*Myosotidium hortense*), a giant forget-me-not at residence of Mr. Collier, St. Clair, Dunedin

Herbs of Lowland Grasslands

Prior to the settlement of the country grassland dominated much of the eastern portions of both the North and South Islands, especially the latter, but between the tussocks there was a numerous collection of herbaceous plants and low-growing shrubs. Characteristic plants of this association included several species of SPEARGRASS or SPANIARD (*Aciphylla*) sometimes termed also BAYONET GRASSES. On the grasslands of the South Island commonest species were the blue Spaniard (*Aciphylla glaucescens*), the shorter and more rigid taramea (*A. aurea*), and a slender flexuose plant of grey-green colour known as *C. subflabellata*. Mustering stock on country where these were plentiful was very painful to both the drover and his mount. In the North Island the commonest grassland species were *C. squarrosa* and *C. colensoi* though this latter species was mainly to be seen on the mountains and uplands. Neither was anything like so common as were the South Island plants. A small area on the roadside between Outram and Lee Stream gives an indication of what the original tussock grassland was like when thickly populated with Spaniard.

Where the ground was moist but scarcely swampy the MAORI ONION (*Chrysobactron hookeri*) with tall spikes of yellow flowers added a touch of colour. On drier ground a buttercup (*Ranunculus multiscapus*), a small daisy (*Celmisia gracilenta*), a delicate bluebell (*Wahlenbergia*), several bidibids (*Acaena*), and a tiny GERANIUM (*G. sessiliflora*) were ever-present species, but none with any claims to distinction. Rather more attractive were a tiny yellow-flowering shamrock (*Oxalis corniculata*), a white or pale-blue BLUEBELL (*Wahlenbergia albomarginata*) a grassy CELMISIA (*C. longifolia*), and the NEW ZEALAND GROUNDSEL (*Senecio bellidioides*).

Herbs of the Shingle Scree and Rock

Huge talus slopes are a feature of most South Island mountains and from a distance appear to be quite devoid of plant life. Closer examination, however,

W. Martin, photo

FIG. 74. Sand-mound 'fixed' by rope-like underground stems and roots of the Spiral Sedge or Pingao (*Desmoschoenus spiralis*)

reveals the presence of isolated herbs and shrubs forming a collection of plants of diverse families and life-form. On the dry shingle screes of Canterbury and Marlborough there are some twenty-five species wholly restricted thereto, and a number of others that frequently invade them though not restricted to them. The prevailing conditions could scarcely be more inimical to plant life. The angle of rest is usually about thirty-three degrees. Extreme fluctuations of temperature and of

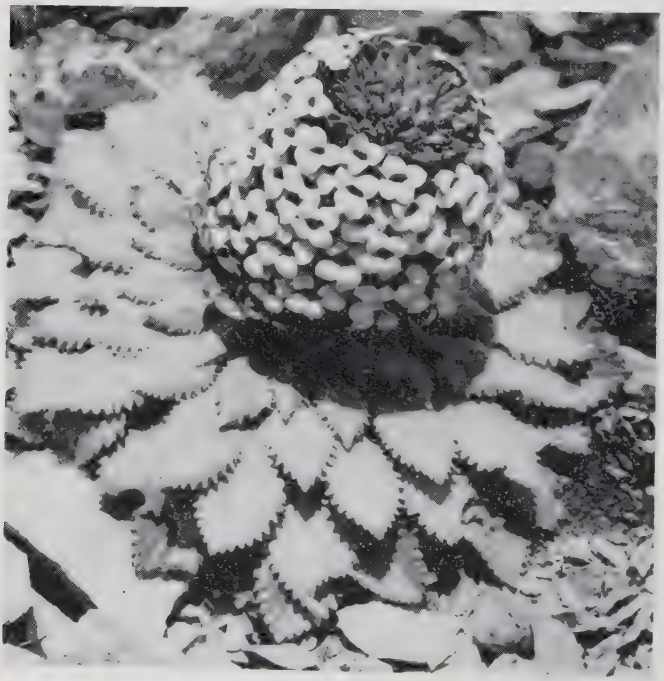
light intensity occur in a matter of minutes. Measurements made by the writer on the Bounds Range in Marlborough showed a drop in a quarter of an hour from a surface temperature of 130° Fahrenheit to 75° Fahrenheit. On another occasion on the St Arnaud Range, there was a difference of 48° Fahrenheit between the surface temperature and that of the stones a foot below. Yet under these conditions *Haastia sinclairii,* a small relative of the vegetable sheep, was growing vigorously and flowering freely.

In such places, exposed to intense actinic light one moment and to deep shade the next, to fierce gales, to an unstable substratum, to sudden temperature fluctuations of extreme range, to frequent frosts, and to prolonged burial under the winter snows, these twenty-five specialist plants have so adjusted their life processes as not to be able to grow elsewhere. A dozen plants from more stable and more consolidated shingle are also found to invade these screes quite frequently. Eight of the twenty-five are shrubs of the genera *Hebe* and *Haastia,* the others being herbs.

On examination we find among these herbs a grass (*Poa sclerophylla*), four fleshy buttercups, four species of forget-me-not (*Myosotis*), a lobelia (*L. roughii*), a chickweed (*Stellaria roughii*), a pretty reddish willow-herb (*Epilobium pycnostachyum*) a scraggy bluebell (*Wahlenbergia cartilaginea*), a daisy with black flowers (*Cotula atrata*), a pea (*Swainsona novae-zelandiae*), a miserable little convolvulus (*C. fracto-saxosa*), and the lovely, fragrant penwiper (*Notothlaspi rosulatum*) of the cabbage family.

Common invaders of the scree include a bidibid (*Acaena glabra*), a woolly daisy (*Craspedia alpina*), the Claytonia (*C. australasica*), a slender anise (*Anisotome filifolia*), and the remarkable stick-plant (*Coral-*

lospartium crassicaule). In any area only a few of the above plants will be detected. Indeed, it commonly happens that the scree plants have the same colour as the stones, or at least harmonize so well with them that it is not easy to detect their presence. None of these specialized plants is to be found on North Island screes other than the willowherb and *Claytonia*, and few are located on the schistose screes of Otago.



A. Wall, photo

FIG. 75. Penwiper Plant (*Notothlaspi rosulatum*), a remarkable plant of the shingle slips

Most scree herbs are summer-green, the shoots dying down before the winter snows, only the root-stock and associated root system remaining to reproduce the aerial parts the following spring. In order to conserve moisture most scree plants have a minimum leaf system and a maximum development of root. Though the leaves may be fleshy and glaucous or densely clothed with furry tomentum, transpiration still remains rapid. According to Fisher the stomata range from five to sixteen thousand per square centimetre in the eight species examined by him.

J. S. Thomson, photo

FIG. 76. New Zealand Flowering Cress (*Cheesemania latesiliqua*) in garden of the late J. Scott Thomson

Several of these plants are restricted to Marlborough or are best developed on the screes of that area. Of these the loveliest, and most arresting as well as the most unique is the penwiper, so called because in its earlier stages the leaves overlap like the old-time flannel penwipers. The plant, being a biennial, flowers in its second year, when it assumes a conical or pyramidal shape from eight to eighteen inches high. A form located on screes of the Shingly Range near the Saxton Saddle has been likened to tiny white-robed mannikins, a very apt description. The flowers are pure white or cream-coloured and deliciously scented. The rock-frequenting species of FLOWERING CRESS (*Cheesemania*) are closely related plants from the same area which occasionally appear on the shingle. When flowering they are truly lovely plants: they are allied to the garden *Nasturtium*.

Other Marlborough shingle plants botanically interesting but without any attractive features are the SHINGLE CONVOLVULUS, the SCREE BLUEBELL, and *Raoulia cinerea,* an ashy-leafed daisy not found elsewhere. Very choice rock-frequenting, floriferous herbs native to Marlborough include the KAIKOURA BUTTERCUP (*Ranunculus lobulatus*), ASTON'S GENTIAN (*Gentiana astoni*), the MARLBOROUGH HARE-BELL (*Wahlenbergia matthewsii*) with purplish stems and pale lilac blossoms, the KAIKOURA WILLOW-HERB (*Epilobium kaikourense*), and the ROCK FORGET-ME-NOT (*Myosotis saxatilis*).

Cotula atrata is unique in having black flowers contrasting strongly with the bright orange anthers. The variety *dendyi* differs in its larger brownish flowers.

Herbs of Bog and Swamp

Mention has already been made of grasses, sedges, and rushes characteristic of swamp and bog, as also

J. S. Tennyson photo

FIG. 77. *Phyllachne colensoi* cushion and *Celmisia hectori* growing on the Humboldt Mts., Otago

of the Sphagna, ferns, and lichens present in these areas; but there are numerous flowering plants, some of very attractive form or bearing conspicuous and beautiful blossoms.

In subalpine bogs one may expect to find several of the following—mossy, green or brown cushions of *Gaimardia ciliata, G. pallida* or *G. setacea* up to a yard in diameter; hemispherical, dark green, compact cushions of *Donatia novae-zelandiae* or of one or other of several species of the related *Phyllachne,* both with copious white blossoms in the summer months; *Oreostylidium subulatum,* sole species of an endemic genus also related to the *Donatia,* but never a cushion former, each plant bearing a single inconspicuous blossom; one or other of several species of sundew or fly-catcher (*Drosera*), of which *D. binata* is the commonest, but *D. spathulata* with bright red leaves, densely covered with glandular hairs, is the most conspicuous; and most charming of all, the bog-gentian (*Gentiana bellidifolia*) and the silvery cushions of *Celmisia argentea* nowhere seen to better advantage than on Mt. Maungatua near Dunedin.

Lowland swamps and bogs too may harbour several of the same plants, especially the sundews and the grass-lily (*Herpolirion novae-zelandiae*). This last has grass-like leaves and a single, large, pale blue or white flower of most attractive appearance. Not the least attractive denizens of lowland swamp and bog however are the blue-flowering orchids of the genus *Thelymitra* which occur throughout New Zealand not only in swamps but also in manuka heaths and elsewhere as well. Various species of *Gunnera* occur, most conspicuous when bearing spikes or clusters of pure white or bright red fleshy drupes. The most common and conspicuous

plant of lowland swamps, however, is the Flax or harakeke (*Phormium tenax*) too well known to need description. A frequent associate is the ubiquitous cabbage-tree (*Cordyline australis*).

J. S. Thomson, photo

FIG. 78. Mt. Cook Lily (*Ranunculus lyallii*), the world's largest buttercup

Buttercups

The subalpine and alpine regions of New Zealand, and more particularly those of the South Island, are the location from which a majority of our finest flowering plants may be obtained. Indeed, some of the natural rock gardens far surpass in beauty and extent anything to be seen at lower levels or in private gardens, if due allowance is made for the absence of red flowers amongst the flowering herbs. Yellow and white are

the prevailing colours of the blossoms. Of these flowering herbs none surpass some of the numerous buttercups (*Ranunculus*) and daisies (*Celmisia* etc.).

J. S. Thomson, photo

FIG. 79. *Ranunculus buchanani* at 7,000 feet altitude, Mt. French, Otago

The number of buttercups indigenous to New Zealand comprises almost fifty species and over twenty named varieties. Pride of place must be given to the so-called MOUNT COOK LILY (*R. lyallii*), to *R. buchanani* from the high mountains of the Lake District of Otago, and to *R. insignis* from the axial chain of the

North Island and from South Island mountains as far south as Kaikoura and Lake Tennyson, which no foreign species can surpass for size or beauty. The Mount Cook Lily has large saucer-like leaves commonly a foot or more in diameter surmounted by a much branched flower stem two to four feet tall bearing numerous pure white flowers two to three inches in diameter. It is restricted to the mountains of Canterbury and Otago save for a small colony on Mount Anglem in Stewart Island; but wherever deer have access to it they eat it greedily. It is truly a noble plant, easily grown in moist ground free from stagnant water.

R. buchanani, like the Mount Cook lily, has a stout root-stock and long fleshy roots. It grows at altitudes of four thousand to six thousand feet, and in consequence is often buried under the winter snows, coming up 'bleached like celery' in the spring. In appearance it bears no resemblance to the former plant for it has much dissected leaves, kidney-shaped in outline, and up to six inches broad. The flowers are very large with numerous white petals and are produced singly as a rule on very short scapes.

From these two white-flowered buttercups, *R. insignis* differs in having golden yellow flowers, as indeed do all the other species. Well-developed flowering plants may be as much as three feet tall with leaves from six to nine inches wide, usually reniform in outline with crenate or slightly lobed margins, and everywhere covered with short hairs. The flowers vary in size from one to two inches across and are the largest and showiest of all the yellow-flowering buttercups.

Two other buttercups of large size which make admirable garden plants are the KAIKOURA BUTTERCUP (*R. lobulatus*) and the GODLEY BUTTERCUP (*R. godleyanus*). The former plant grows plentifully on

W. Martin, photo

FIG. 80. The Kaikoura Buttercup (*Ranunculus lobulatus*) in garden of Mr A. E. Brockett, Blenheim

the foothills and coastal cliffs between the Awatere River and the sea in Marlborough. It makes a particularly choice, easily-cultivated garden plant with large saucer-shaped or reniform leaves and tall branching flower stems. The yellow flowers, however, are variable both in the number and width of the petals. The Godley buttercup differs in its spoon-shaped leaves with wedge-shaped base and crenate margins and in its larger flowers on stouter scapes. It is found only on the Canterbury Alps or on their western flanks, being most common near the head of the Rakaia River.

One of the most ornamental plants of subalpine scrub on Mt. Egmont is the EGMONT BUTTERCUP (*R. nivicola*), a fine species of herb equally common on the Central Volcanoes of the North Island. The leaves are deeply lobed, round in outline, and carried on long slender leaf stalks. The large panicles of bright golden-yellow flowers are particularly showy.

One very remarkable buttercup restricted to bare, unstable shingle screes of the South Island (*R. haastii*) is quite distinct from all other known buttercups. It has several fleshy leaves, glaucous in colour, and quite smooth save for the villous leaf sheaths. These leaves are rarely more than a few inches high and die down before winter. Each is deeply divided into sharp-pointed lobes and the solitary yellow flower usually measures at least an inch and a half in diameter. What is probably the rarest buttercup in existence is represented by a dozen plants at most in one small area of three acres in Canterbury. Like the previous plant this buttercup (*R. pauciflorus*) produces a solitary flower on each scape about two inches wide and remarkably large for the size of the plant. In order to secure it against extinction the area is now enclosed to keep out all grazing animals. Rather less rare, but nowhere common so far as is known

J. S. Thomson, photo

FIG. 81. *Ranunculus matthewsii*, a hybrid buttercup *R. lyallii* × *R. buchanani*

is a third shingle-dwelling buttercup (*R. crithmifolius*) from the Arrowsmith and Spenser Mountains, but with leaves twice divided into three and very much dissected. A fourth shingle-frequenting species (*R. chordorhizos*) is a small, greyish, high altitude plant with small three-lobed leaves, each scape having but a single large yellow bloom. Two species of *Caltha*, a related genus, are found in alpine regions, these being very small plants with a terminal notch in each leaf. *C. novae-zelandiae* with pale yellow flowers reaches sea level on Stewart Island but *C. obtusa* with white flowers is strictly an alpine plant.

The Daisy Family: Celmisias

The daisy family is well represented in the New Zealand Flora by some thirty genera, six of which have no foreign representatives. The number of species lies somewhere between 250 and 300, a great majority being herbaceous plants, some quite unattractive; but on the other hand many are plants of supreme decorative or horticultural merit. The plants coming in this category belong to five genera—*Celmisia, Pleurophyllum, Leucogenes, Helichrysum,* and *Senecio*—which we will consider in that order.

Until someone undertakes the difficult task of monographing the genus with its numerous species, varieties, forms, and hybrids, it is not possible to state the exact number of *Celmisias,* but the number of species clearly exceeds sixty, only one of which (*C. longifolia*) is found outside of this Dominion, occurring as it does both in Australia and Tasmania.

What is regarded by many as the finest and noblest species is that sometimes termed the COTTON PLANT (*C. coriacea*) or LEATHER PLANT, in several of its numerous forms. This plant is widespread on the

mountains of the South Island, the commonest form having a rigid rosette of semi-upright, broad, pointed leaves, silvery on both surfaces, and numerous upright, single-flowered scapes far overtopping the leaves. Each flower, according to the variety and locality, varies in width from two to five inches with such numerous ray florets as to appear semi-double. In common with every other species, the flowers have white rays and with two

W. Martin, photo

FIG. 82. *Celmisia coriacea*, Arthurs Pass, Canterbury

exceptions yellow disc florets. This plant transplants readily and grows well in cultivation so long as the air is not too dry and the soil is well drained. Whether with or without flowers *C. coriacea* is a striking plant in any garden. Two Otago varieties are of particular merit, var. *stricta* because of its longer, rigid white leaves and taller scapes, and the smaller var. *lanigera* because of the copious long, white, woolly hairs that cover the leaves. *C. monroi* of Marlborough differs little from *C. coriacea*.

Of the other large species suitable for garden culture mention must be made of *C. hookeri* from the foothills of North Otago and of a similar but larger daisy (*C. verbascifolia*) from the Otago fiords, with flowers as much as four inches in diameter. From this same locality comes the particularly fine SOUNDS DAISY (*H. holosericea*), a branching species that bears numerous flowers on slender stalks upwards of two feet tall, and numerous rosettes of green, slightly viscid leaves.

Several *Celmisias* immediately arrest attention from the reddish brown tomentum that covers the underside of the leaves and margins their edges. Finest of these is *C. traversii*, a not uncommon plant of fairly high levels on the western mountains of the South Island. This handsome plant has broad green leaves with purple midribs and petioles, rich reddish-brown furry margins, and copious white wool on the sheathing bases. Even the flower scapes and bracts are covered with rich old-gold tomentum. Some of its hybrids are scarcely less attractive and are easier to maintain in cultivation. The rather rare *C. cordatifolia* has tomentum on the underside of the leaves coloured as in *C. traversii*, but in this plant the leaves are only two to four inches long with a heart-shaped, blunt-tipped blade. It occurs at 5,000 feet altitude on the Wairau Mountains either on

J. S. Thomson, photo

FIG. 83. *Celmisia hookeri* from Horse Range, Otago, in garden of the late J. S. Thomson

rocks with a soil veneer, or on the sides of rocky alpine couloirs.

A very fine Celmisia, especially on the western aspects of the Alps, best recognised by its narrow purple midribs and petioles, is a tufted plant with narrow oblong leaves about a foot long, known as *C. petiolata*. It is the commonest of the mountain daisies near the Mount Cook Hermitage. An equally fine plant abundant on Arthurs Pass known as *C. armstrongii* may be recognised by its rigidly erect leaves with orange midribs and silvery tomentum. These are narrow, sharp-pointed, and ribbed.

These Celmisias all have more or less erect leafy rosettes, but there is another group with branching stems, each branch ending in a tuft of leaves usually of no great length and together forming a plant of cushion or mat-form covering a considerable area. Such a one is the NUGGETS DAISY (*C. lindsayi*) which grows on the coastal cliffs south of the mouth of the Clutha River in Otago. The leaves are somewhat sticky but the plant is eminently suited for garden cultivation. The allied *C. bonplandii* from Western Otago is very similar in habit and appearance. A still finer plant with the same habit is *C. holosericea* from the West Coast sounds.

Many of the smaller species are similarly much branched and carpet the ground for extensive areas, especially at high altitudes where snow lies long in winter. To this group belong the SNOW ASTER (*C. viscosa*), the WHITE MOUNTAIN MUSK (*C. incana*), the SILVER ASTER (*C. hectori*), and many others. The last of these is easier to handle as a garden cultigen than are the other two. *C. incana* has pure white woolly leaves; *C. viscosa* numerous, narrow, plaited, very viscous leaves usually without tomentum. It is of interest

that when the spring thaw sets in the snow disappears off these plants and for an inch or two all round them while it still thickly coats the ground between them, in the same manner as it would were the plants themselves the source of the heat causing the thaw.

W. Martin, photo

FIG. 84. *Celmisia cordatifolia* from Mt. Fishtail, Marlborough, and a hybrid daisy from Red Hills

The bog aster (*C. argentea*) differs from all previously mentioned in forming a dense cushion similar to that of a vegetable sheep. It is confined to subalpine bogs; but when summer comes each cushion is partially concealed by numerous large, sessile, daisy flowers, so that it rivals the plant known in gardens as 'Snow in Summer'. It can be grown quite successfully on an artificial scree. A somewhat similar plant (*C. sessiliflora*) has

larger and more open cushions and stalked flowers. It too is an alpine plant common in open spaces where snow must cover it for weeks at a time.

Bog-frequenting Celmisias are not numerous, one of the commonest other than the bog aster being a small creeping plant, with prostrate stems and small, serrated,

J. S. Thomson, photo

FIG. 85. *Celmisia argentea* on summit of Mt. Maungatua, Otago

green leaves known as *C. glandulosa*. It is abundant on Mount Egmont, but in one form or another is quite widespread. Rock species are also few, the finest being *C. cockayniana* which occurs on most of the mountains of eastern Marlborough, and *C. bellidioides* a more widespread and lovely species frequenting wet subalpine rocks from Nelson to Otago. The leaves are glabrous, somewhat fleshy and very small.

J. S. Thomson, photo

FIG. 86. *Celmisia armstrongii* and *Gentiana corymbifera* with *Ourisia macrophylla* in background

One or two species have distinctly woody stems. Though scarcely ever much more than six inches high. *C. ramulosa* from Central and Western Otago has a rigid erect woody stem surrounded by small appressed leaves white on the lower side and green above. The only similar species is a larger plant, with sharp-pointed linear leaves not more than an inch long and green on both surfaces, named *C. lateralis,* and confined to Nelson and northern Westland. *C. walkeri* is a large

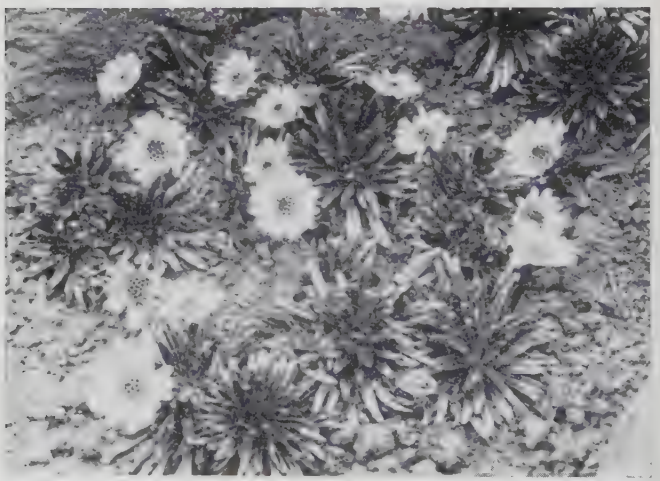
W. Martin, photo

FIG. 87. *Celmisia ramulosa* from Rock and Pillar Mts., Otago

plant with woody lianoid stems, up to four feet long when scrambling through a subalpine shrubbery in Western Otago. The shepherd's daisy (*C. spectabilis*) is one of the most common of all the Celmisias from north of Otago to the Volcanic Plateau. In all of its many forms it is easily recognised by its rigid, narrow.

erect, furrowed leaves 6 to 8 inches long with pale buff spongy tomentum below. It is a perennial of easy garden culture.

One of the very finest Celmisias (*C. vernicosa*) comes from the Auckland and Campbell Islands, and is at once recognised by its polished linear leaves, numerous scapes, and purple-centred white flowers.



J. S. Thomson, photo

FIG. 88. *Celmisia vernicosa* from Campbell Island, in garden of the late J. Scott Thomson, Dunedin

Other Daisies

The subantarctic islands are the home of a 'magnificent assemblage of herbaceous plants unrivalled in beauty on the mainland of New Zealand', to quote R. M. Laing. As the author has not been able to visit these islands, let the late T. Kirk tell of the genus *Pleurophyllum*. He says:—'The genus *Pleurophyllum* is

restricted to these islands and contains three grand species—*P. speciosum* the leaves of which form a flat rosette 3 feet to 4 feet in diameter from the centre of which rise several stems 1½ feet to 2½ feet high, carrying numerous pedunculate, rayed flower heads, 1½ inches in diameter, with whitish rays and deep rich purple centres. The leaves are grooved longitudinally, and lie perfectly flat: the effect is unique, and as the plant often cover acres, approaches the magnificent. As the traveller walks amongst them his feet crash through the horizontal leaves as though he were walking on thin ice: *P. criniferum* is of a very different habit; the leaves are usually petioled and from 1½ to 3 feet in length, sub-erect, and spreading, forming a ring round the erect scapes which are from 3 feet to 4 feet high; the flowerheads resembling large velvet-covered buttons of a deep-brown colour, contrasting well with the snow-white tomentum of the scape and peduncles.' *P. hookeri* is much smaller and has silvery coated, sage-green leaves and large purple flowers without conspicuous ray florets.

To the genus *Leucogenes* belong our two species of New Zealand edelweiss. How closely they resemble the Swiss edelweiss (*Leontopodium*) is indicated by the use of that name to describe the species *L. leontopodium*, the only species found on the mountains of the North Island. *L. grandiceps* is confined to the South Island mountains and to Stewart Island. It differs from the other in having smaller leaves recurved at the tips. Both plants are everywhere clothed with white or silvery tomentum, and the flannel-like 'flowers' are surrounded by woolly bracts.

Helichrysum, to which genus the coral shrub belongs, has three herbaceous species of which the *H. bellidioides*, confined to the South Island, and *H. prostratum*,

I. Speden, photo

FIG. 89. Edelweiss (*Leucogenes grandiceps*)

to the North Island, are the most attractive. Every stem ends in a solitary daisy flower, pedunculate in the southern species and generally sessile in the other; and so numerous are they that every patch becomes very conspicuous and attractive. Each is usually known as the MOUNTAIN EVERLASTING. Closely allied are four species of *Gnaphalium* with radiating white bracts and much-branched terminal 'flower' clusters. The largest of these (*G. lyallii*) is recognised at once by the large three-nerved leaves up to an inch long and by the large flower-heads. *G. trinerve* is more slender but similar, and found more commonly at low levels as on Otago

J. S. Thomson, photo

FIG. 90. Snow Marguerite (*Senecio scorzoneroides*)

J. S. Thomson, photo

FIG. 91. Mountain Everlasting (*Helichrysum bellidioides*)

Peninsula or on Stewart Island, on roadside banks, or coastal cliffs. *G. keriense* ranges from North Auckland to Nelson and has smaller flower-heads, but each of these plants compels admiration.

Of fifteen or sixteen herbaceous species of *Senecio,* the most outstanding and charming is without doubt that known as the SNOW MARGUERITE (*S. scorzoneroides*) which in the opinion of the author is not surpassed for all-round elegance by any other member of the subalpine flora, beautiful as so many of them are. From a basal rosette of summer-green grassy leaves each six to eight inches long and over half an inch wide, there arises a robust leafy stem terminating in a large, broad corymb with numerous white daisy flowers usually over two inches wide on rather long flowerstalks. Seen in large colonies amongst subalpine shrubs especially on a river flat as at the Homer Tunnel or on the herb-fields of Table Hill at Stewart Island, the effect is most charming, the more so when, in the company of the smaller yellow-flowering *S. lyallii,* numerous hybrids are present with cream or salmon tinted blossoms to add variety of colour.

One of the commonest and most variable of the Senecios is *S. bellidioides,* a small grassland daisy with rosettes of broad, usually rugose leaves. *S. haastii* is similar but more attractive because of its white colour. A much larger plant of similar habit is *S. saxifragoides* which grows sparingly on the Lyttelton hills and on Mount Fyffe in Marlborough, where the writer once secured giant plants a yard across. All the above Senecios are absent from the North Island. Of quite different habit are four North Island species, one of which ranges as far south as Ross in Westland. This is *S. solanderi,* a tall glabrous plant sometimes four feet tall with large trusses of golden-yellow flowers, well developed for

instance in the Buller Gorge. *S. banksii* and *S. turneri*, the former with leaves at most two inches broad, the latter with cordate leaves three times as broad on long petioles, when flowering, may attain the height of a man. Both have numerous bright yellow blossoms of large size in *S. turneri*, but quite small in *S. banksii*.

The Cabbage Family

Members of this family have flowers with 4 sepals, 4 petals, 6 stamens (4 long and 2 short) occasionally

J. S. Thomson, photo

FIG. 92. *Cotula pyrethrifolia*, a high altitude daisy

reduced to 4 or even 2, and a 2-celled ovary. The fruit is always a two-chambered pod with a membraneous partition, from which the outer valves ultimately fall away, and which is known as a siliqua if long and a silicle if short and broad. To this family belong such garden vegetables as the cabbage, turnip, swede, or cress; and such common flowering plants as the wallflower, *Aubretia*, candytuft, and *Nasturtium*.

W. Martin, photo

FIG. 93. Spear grass (*Aciphylla glaucescens*), Kahutara Saddle, Seaward Kaikoura Mts.

There are over two dozen New Zealand representatives belonging to eight genera, but the only conspicuous flowering species are such as belong to two endemic genera—*Cheesemania* and *Notothlaspi*. The five species of *Cheesemania* are mainly rock-frequenting plants of high altitudes centred in Nelson and Marlborough. They all possess a long root-stock as thick as one's finger, surmounted by a rosette of densely crowded, serrated leaves from which arise several erect flowering stems. These are densely branched and carry numerous corymbs of large white flowers, so that the plants are most conspicuous and attractive. The commonest is *C. fastigiata,* ranging as it does to the Garvie mountains in Otago, but that known as *C. latesiliqua* is an even more handsome herb with larger flowers and hair-coated leaves. All these five species of FLOWERING CRESS are very sweet-scented.

Notothlaspi is a genus of two species and two named varieties. Reference has already been made to the larger species usually known as the PENWIPER (*N. rosulatum*). It is a biennial plant of the dry shingle slopes of Nelson and Marlborough. The first year, plants form a dense rosette of overlapping fleshy leaves in the shape of low cushions surmounted in January next year by a short, densely flowered, stout scape covered with fragrant white flowers forming a conical raceme, and quite unlike any other plant in its general appearance. None but the most casual could pass it by without stopping to admire it. The second species is a smaller plant with spreading leafy branches, each terminating in a dense corymb of white blossom. It is very common on shingly soils from three to five thousand feet altitude on many mountains of Nelson and Marlborough, and is named *N. australe*.

A coastal plant once abundant from the Kermadecs

to the Auckland Islands but now quite rare on the mainland is that known as CAPTAIN COOK'S SCURVY-GRASS (*Lepidium oleraceum*). Its pungent leaves were found to be a useful antidote to scurvy, for which purpose it was much used by the sailors who accompanied Cook on his southern voyages.

J. S. Thomson, photo

FIG. 94. *Aciphylla congesta* in garden of the late J. Scott Thomson

Spear-grasses and their Allies

The genus *Aciphylla* is characteristically a New Zealand genus of thirty-eight species of Umbelliferous herbs ranging in height when in flower from a few inches to ten feet or more. More than half of these

are more or less grassy herbs but at least a dozen are large plants with pungent, 2-3 pinnate leaves, from which the flower-stalks arise with numerous compound umbels protected by spinous bracts, arranged along the sides of the upper parts. These flowers are either male or female. Many of the smaller species have more or less globose heads, often as in *Aciphylla crosbysmithii* with very numerous flower-stalks arising from massive clumps.

The spear-grasses are, of course, not grasses at all being relatives of the carrot and parsnip, and the taller and more spinous species are often known by the alternative name of Spaniard. THE GIANT SPANIARD, once known as *A. maxima*, is now termed *Aciphylla scott-thomsoni,* a species common on Maungatua and other hills near Dunedin, but nowhere reaching more massive proportions than on Harris Saddle at the head of the Routeburn River where the leaves may be as much as five feet long and the flower stalks ten feet or more tall. Even on Mount Maungatua plants may be six to eight feet tall.

Another species of similar glaucous blue colour is common on the grasslands of Otago but ranges north to East Cape. This is *A. glaucescens,* hitherto an unnamed species, botanically similar to *A. squarrosa* though quite unlike it, for which I propose the name of Blue Spaniard. *A. squarrosa* was the first species discovered. It was obtained by Dr Forster in Queen Charlotte Sound in 1776 but is common throughout the southern half of the North Island. It is represented in the South Island by the similar greyish-green *A. subflabellata.*

The TARAMEA (*A. colensoi*) as formerly understood comprised three distinct species. The true species ranges south from East Cape to the mountains at the

head of the Rakaia River in Canterbury, while *A. aurea* is strictly confined to the South Island uplands. Its rigid spinous leaves were much disliked by both horses and men in the early days, for, in parts of Central Otago it was a dominant plant in much of the grasslands.

There is a very broad-leafed species known as *A. horrida* which forms massive clumps on the wetter western mountains of the South Island. The leaves

J. S. Thomson, photo

FIG. 95 *Aciphylla simplex* in garden of the late J. S. Thomson

comprise five, seven, or nine leaflets with two long leaf-like stipules at the head of the leaf sheath. On the drier mountains of Marlborough and Nelson it is replaced by the similar *A. ferox*. Many of the smaller species grow at elevations of six and seven thousand feet. Such are *A. dobsoni* with trifoliate leaves, *A. simplex* with simple leaves lacking stipules from Central Otago, and *A. leighi* from the Darran Range which forms wide spreading patches at 6,500 ft. altitude. The only species with pinnatifid leaves is aptly

J. S. Thomson, photo

FIG. 96. *Anisotome pilifera*, an aromatic and ornamental umbelliferous herb

named *A. pinnatifida* and the smallest species is *A. polita* from the Tararuas and the mountains of Nelson.

The Aciphyllas are predominantly established on the mountains of the South Island, only six species being known from the North Island. *C. traillii* is restricted to Stewart Island, *C. intermedia* alone is confined to the North Island, and *C. traversii* alone to Chatham Island.

All the many New Zealand members of this world-ranging family are aromatic herbs related to the carrot, parsnip and celery of the vegetable garden. Exclusive of the spear-grasses there are over fifty indigenous representatives of this family belonging to a dozen different genera, chief of which in number of species is *Anisotome*. Much the largest and most conspicuous of twenty species are two noble species from the Auckland and Campbell Islands (*A. latifolia* and *A. antipoda*), which develop furrowed flower stalks up to eight feet tall in the first of the two and up to four feet in the latter species. In both, the leaves are from one to two feet long, but in *A. antipoda* they are more finely dissected, with the ultimate segments linear and pungent.

Of the mainland species only two reach the North Island and only two occur on Stewart Island. The finest species are *A. haastii* and *A. pilifera*, both ranging from Nelson to Otago on the western ranges. The latter in particular is a very conspicuous and attractive plant when in bloom, for the flowers though individually small, are white and massed in large umbels. Its robust fleshy stems, large, much dissected leaves, and attractive flower heads make it a very conspicuous ornament of the rocky hillsides or ledges where it is usually found. *A. haastii* closely resembles it from a distance but the leaves are bipinnate, tripinnate or even 4-pinnate, and the ultimate lobes are hair-pointed. *A. intermedia* is yet another robust species confined to

coastal stations in Otago, Stewart Island, and the near-by islets, the stems of which when broken exude a white, milky, sticky sap. The SCREE PARSLEY (*A. carnosula*) is a small, fleshy, glaucous species that invades the

J. S. Thomson, photo

FIG. 97. Punui (*Stilbocarpa polaris*) from Campbell Island in garden of the late J. Scott Thomson

talus slopes so abundant on the eastern slopes of the mountains in and north of Canterbury, as does *A. diversifolia* in eastern Nelson.

A. aromatica is a small variable plant with no claim to special mention other than that it is the only species common to both the North and the South Islands.

Miss Reynolds, photo

FIG. 98. Maori Anise (*Angelica montana*)

While it is true that a majority of our umbellifers are resident on the mountains, others prefer the seashore. Besides the two species of SEA-CELERY (*Apium*) previously mentioned, the prickly SEA-HOLLY (*Eryngium vesiculosum*) is not an uncommon coastal plant between East Cape and Canterbury, where it has occasionally been observed in inland stations as well. The three species of *Lilaeopsis,* better known by the former name of *Crantzia,* are slender coastal herbs with transversely septate leaves, also found on the shores of inland lakes. Two scandent species of *Angelica* (*A. geniculata* with simple leaves, and *A. rosaefolia* with pinnate leaves) are further umbellifers common near the coast but by no means restricted to such places. The latter is not known today from any South Island habitat, though Raoul once reported it as growing at Akaroa. It forms extensive mats on some North Island pumice river-beds.

A third species of Angelica (*A. montana*), the MAORI ANISE, was at one time an abundant herb with glaucous, pinnate leaves found on cliff faces and on moist tussocky country south of Lake Taupo to Southland. However, stock eat it greedily with the result that today it is found only in places inaccessible to grazing animals. It is normally less than a foot tall with flowerstalks rarely exceeding eighteen inches. It has a very strong scent of aniseed.

Eight genera have but a single New Zealand species, the NATIVE CARROT (*Daucus brachiatus*) and the MOUNTAIN MYRRH (*Oreomyrrhis andicola*) being two with no very attractive features. The carrot alone has prickly fruits. On Chatham Island there is a monotypic genus (*Coxella*) now approaching extinction with features resembling the spear-grasses. Each plant is about a foot tall, rarely two feet, but the leaves never terminate

J. S. Thomson, photo

FIG. 99 The Goblet Aster (*Pleurophyllum speciosum*) from Campbell Island in garden of the late J. Scott Thomson

in pungent points. The fruits are conspicuously winged. There are now probably more plants in cultivation than growing wild.

The Rose Family

The rose family is represented in New Zealand by only four genera, the climbing or scrambling 'lawyers' (*Rubus*), and three herbaceous genera—*Geum* with seven species, *Potentilla* with one, and the bidibids (*Acaena*) with numerous distinct species and varieties.

Of the Geums, *G. urbanum* var. *strictum* is much the largest with a leafy stem one to three feet high and yellow flowers; but though widely distributed, it cannot be described as common. The radical leaves are pinnate with seven to eleven serrated leaflets, the terminal one being much the largest.

The genus *Acaena* is abundantly represented, especially in the South Island. Opinions differ as to the status of some of these plants so that the distinction between species and varieties is not always to be clearly drawn, but there are fully two dozen distinct forms. The centre of dispersal was probably the Andes Mountains of South America, which would account for the barbs on the fruits, as New Zealand, having no indigenous mammals, would be a very unlikely place for such to have developed initially. In fact several of the New Zealand endemic forms have spines without barbs.

The common bidibid (*A. sanguisorbae*) has long trailing stems prostrate and woody at the base, but herbaceous and leafy above. The leaves are always pinnate, usually with seven to thirteen leaflets, each pair larger than those below. The fruiting heads are green at first then brown or reddish brown. This plant is only too well known from the ease with which these

W. Martin, photo

Fig. 100. Wild Flowers, Frazer Peaks, Stewart Island—*Senecio lyallii* (left); *Celmisia polyvena* (centre); *Olearia colensoi* (right); Maori Onion (*Chrysobactron gibbsii*) (back)

barbed, spinous heads attach themselves to one's clothing. The name 'bidibid' is a corruption of the Maori 'piripiri'.

A second species (*A. novae-zelandiae*) may be distinguished by the larger leaves with eleven to thirteen leaflets, the purplish scapes, and very large reddish or purplish globose heads. Its variety *pallida,* still to be seen on Otago Peninsula and at Lyall Bay in Wellington, is even larger, with heads sometimes an inch and a half in diameter. The leaves far from being pallid, however, are dark green.

A. microphylla is a smaller species forming large patches, which, when almost completely covered with bright red, barbless spines, is a really handsome herb quite suitable for garden culture. *A. inermis* likewise has no spines at all. *A. buchanani* of Central Otago is an abundant and very distinct species with yellow spines. On ridge tops and on stony South Island mountain slopes, *A. saccaticupula* is yet another common species best recognised by the fruiting scapes which grow rigidly erect to a height of six to nine inches. *A. glabra* is a robust, glabrous, subalpine species that sometimes invades the shingle slips of the South Island mountains.

The Fuchsia Family

The only herbaceous fuchsia (*F. procumbens*) is a prostrate, trailing species restricted to a few isolated sandy or rocky places on the coasts of North Auckland, remarkable in that the flowers are erect and of three distinct forms with long, medium, and short styles respectively. Mr. Cheeseman with good reason has suggested that 'the long-styled form with its larger stigma and somewhat smaller anthers, is simply a variety advancing in the direction of becoming a female plant; while the short-styled variety, with its smaller stigma

and abundant pollen, is in a similar way tending in the direction of becoming purely male'. It is specially attractive when covered with its very large oblong, bright purple berries. The other three New Zealand fuchsias include a tree, a bushy shrub, and a climber.

The only other New Zealand genus is *Epilobium,* to which belong about forty herbaceous plants commonly known as WILLOWHERBS with not the slightest external resemblance to the *Fuchsia.* Some species are tall and erect, others creeping and prostrate, with others small and bushy.

One of the tallest is the SWAMP WILLOWHERB (*E. pallidiflorum*) easily recognised at a glance by reason of its size (2 to 4 feet) its long, acute, serrated leaves, and its large white flowers. It occurs in swamps throughout the country. The flowers are occasionally suffused with pink. The capsules are sometimes as much as four inches long and when ripe split into four valves to liberate the pappus-tufted seeds. *E. billardierianum* is another erect swamp-lover with reddish stems, broad blunt leaves, and small red flowers; while *E. erectum* is taller and sparingly branched, with long, narrow leaves, and small purplish flowers.

Very different from these is *E. macropus,* a plant that thrives on the margins of running streams in subalpine habitats. The leaves are short, rounded, and in opposite pairs. Its numerous white or rose-tinted flowers are highly ornamental and particularly so in var. *kaikourense* where the flowers are larger and more numerous. Several species are characteristic of the shingly beds of South Island rivers, none more so than *E. melanocaulon* with very dark, purplish black, four-sided stems and small reddish leaves.

Several species go to the other extreme and take up their abode on the shingle slips. Of these *E. pycnosta-*

chyum is one of the commonest; but *E. rubromarginatum* is equally so in the north of the South Island. Both have short stems with closely spaced leaves, though the leaves and flowers of the latter plant are larger than in the former; and, as the name indicates, there is a red marginal line round the leaves.

W. Martin, photo

FIG. 101. *Gentiana astoni,* from Weld Cone, Marlborough

A specially choice high level willowherb restricted to the mountains of northwest Nelson known as *E. vernicosum* has polished red leaves and large rose-tinted flowers; while *E. brevipes* from similar stations in Marlborough and Canterbury, a very similar closely allied species, is distinguished by its narrower, reddish, glossy leaves and smaller flowers sometimes white but frequently rose-tinted as in *E. vernicosum.* Both grow on rock or on rocky soils and shingle.

The Gentians

Gentians are well represented in New Zealand, more particularly in the South Island, for only three of two dozen species are met with north of Cook Strait; and several constitute some of the choicest ornaments of the herb-fields notwithstanding the prevailing white colour of the flowers. Several species from the Chatham and Auckland Islands have white flowers also, but these are usually striped with pink or purple. Occasionally *Gentiana cerina* of Auckland Island has red flowers instead of the normal red stripes on a white ground. Outside of New Zealand white flowers are absent, the more usual colours being bright 'gentian blue', red, purple, or yellow.

Were it not that gentians are notoriously difficult to transplant, several of the native species would be much more commonly grown in flower gardens than is the case. However, since all species contain a bitter alkaloid that ensures immunity from the attentions of deer and other animals, they are less likely to be depleted than such other floral gems as the Mt. Cook Lily, or the cotton plant (*Celmisia coriacea*).

The two finest though exceedingly variable species are the SNOW GENTIAN (*G. corymbifera*) and the ALPINE GENTIAN (*G. montana*). The first of these is a tall alpine plant which thrives on the poorer and drier soils of the Southern Alps and also in scrub, or on rocks up to six thousand five hundred feet. Flowering plants may be eighteen inches to two feet high, with numerous flower-stalks arising from the axils of the upper leaves, each bearing large terminal corymbs or umbels of big white flowers. Such plants dotting the herbfields or landscape in unbroken succession for acres at a stretch provide a floral display not soon forgotten. *G. montana* is a somewhat stouter species with narrow cauline

leaves, closely resembling the snow gentian, though the individual flower-clusters and flowers are larger. Both are perennial herbs confined to the South Island.

Only slightly less conspicuous because of the fewer flowers on each stalk and its smaller size (under a foot) is the gentian known as *G. bellidifolia,* a plant of wider distribution in that it extends its range north to East Cape. Rocks and coastal banks exposed to salt spray on the western and southern South Island are the location of the bushy COASTAL GENTIAN (*G. saxosa*) with one or more white flowers terminating each of its numerous branches. This fine little plant grows in similar stations in Stewart Island also; but an even finer and very distinct species (*G. astoni*) grows on the riverbeds and limestone rocks in the neighbourhood of the Ure and Flaxbourne rivers of Marlborough and also on the limestone rocks topping the coastal hills near Waipara in Canterbury. This is a slender, much branched, and very floriferous plant quite unlike the other species. Equally choice is *G. townsoni* from north-west Nelson with short, crowded, fleshy leaves and dense flower heads. A much smaller annual species (*G. grisebachii*) ranges from 4,000 feet altitude on Mt. Tongariro to sea level in Otago. Each stem lies prostrate in the grass and produces a solitary flower at the tip. All species are endemic to New Zealand, but many are hard to identify.

Forget-me-nots

Much the finest forget-me-not in the world is the large, rhubarb-leafed CHATHAM ISLAND LILY so called, sole member of the endemic genus *Myosotidium* (*M. hortense*). Formerly this magnificent plant girdled the Chatham Island just above high-tide level; but, owing to the depredations of sheep and pigs, it has been

W. Martin, photo

FIG. 102 — An alpine Forget-me-not (*Myosotis saxetilis*) from Blue Mt., Marlborough, in garden of Mr. J. H. Hadfield, Blenheim

almost exterminated in its natural haunts, though it is well established in horticulture. Each plant is a fine succulent herb with large glossy, corrugated leaves a foot long and almost as broad, surmounted in summer by copiously flowered cymes of blue-centred white flowers.

The forget-me-not family is well represented in New Zealand by about three dozen species of which all but two have white or yellow flowers, the principal exception being the lovely *Myosotis capitata* of the Auckland and Campbell Islands with flowers of deepest blue. An almost identical plant (*M. albida*) but with white flowers, grows on coastal banks in Southland, Stewart Island, and the outlying islands including the Snares and the Solanders. It is perhaps somewhat more robust and coated with white tomentum, as are so many other New Zealand species. *M. explanata* of the Canterbury Alps resembles it, but has larger white flowers.

Very fine also are *M. saxatilis* from the Shingly Range and the Blue Mountain in Marlborough, and *M. cockayniana,* a white shingle plant from the same area but possessing pale yellow blossoms. *M. traversii* from shingle slopes on the Alps is similar and has almost identical flowers, but is a rather smaller plant.

One of the finest of the larger forget-me-nots is *M. laingii* from the mountains of Marlborough and eastern Nelson. This has deep yellow flowers of large size and pure white, woolly leaves. Flowering stems may be a foot high. The largest flowers are to be found on *M. macrantha,* a fairly common plant on the western slopes of the alpine chain of the South Island and on Mt. Torlesse. These are brownish-orange and deliciously scented, about an inch in diameter, and carried on stems commonly over a foot high. Of more than thirty species

W. Martin, photo

FIG. 103. *Parahebe catarractae*, Botanical Gardens, Dunedin

only ten are met with in the North Island, the finest being *M. amabilis* from Mt. Hikurangi near East Cape, and *M. petiolata,* a slender plant with yellow-centred, white flowers and few leaves, which is occasionally seen south from Auckland to the Mt. Arthur Plateau in Nelson.

Several native forget-me-nots respond well to garden culture, but others do not long persist 'in captivity' and all are somewhat difficult to raise from seed.

Herbs of the Foxglove Family

To this plant family belong many choice shrubs and herbs of our flower gardens such as *Calceolaria, Antirrhinum,* and *Mimulus.* To it belong also ten New Zealand genera including *Hebe, Ourisia,* and *Euphrasia,* each with numerous species. Besides the arborescent and shrubby species of *Hebe* previously referred to, there are more than a dozen herbaceous or suffruticose species sometimes listed as *Parahebe,* and three mossy cushion-formers distinguished as species of *Pygmaea.*

Much the showiest of these *Parahebes* are *P. catarractae* and *P. linifolia,* the former a tall graceful plant with leaves up to four inches long, and in season long sprays of white or rose-tinted blossoms each fully half an inch wide. Of this species there are, however, many forms. It ranges from Thames to West Otago but is restricted in the South Island to river valleys west of the axial chain. *P. linifolia* is restricted to the South Island; and, like the others, does not grow naturally east of the Southern Alps. It forms a small, compact, ball-like clump usually on moist rocks close to a stream, and is most attractive when in January it is closely surrounded by its large pinkish or white blossoms.

P. lyallii has a more prostrate habit with upturned branches. The flower-stalks arise from near the ends

of the stems and bear white lavender-striped flowers. Though ranging from the Ruahine Mountains to South Otago, it is rare on the eastern side of the South Island, the writer having seen it only once (in the valley of the Ure River in Marlborough). There is, however, an even

W. Martin, photo

FIG. 104. Mountain Primula (*Ourisia macrocarpa*)

smaller mat-forming species (*P. bidwillii*) practically restricted to the shingly riverbeds of eastern South Island rivers, which may be recognised by the uniform but tiny leaves, much-branched prostrate habit, and especially by the tall, naked, erect flower-stalks bearing small whitish or pinkish flowers only on the upper half. Of the three species of *Pygmaea*, *P. pulvinaris* is abundant on the high mountains of Canterbury, Nelson and Marlborough; *P. thomsoni* is restricted to Otago;

and *P. ciliolata* occurs throughout, but none crosses Cook Strait. All are much alike, forming tiny mossy cushions usually on fine shingly soils at high altitudes, and rarely exceeding three inches in diameter. Smallest of all the Hebes, however, is *Parahebe canescens*. This has a short, creeping, threadlike stem with leaves no larger than a pinhead and usually coloured like the shingle or mud on which it grows. The pale-blue flowers, however, borne singly in the axils of the leaves, render the plant immediately conspicuous. It occurs usually on dried mud on the margins of upland tarns, but in Central Otago the writer has observed it quite commonly on a barren sunbaked roadside near Omakou and again near Mt. Ida.

The genus *Ourisia* has almost a dozen endemic species amongst which are some highly ornamental herbs that can rank amongst the finest in the flora. Outside of New Zealand, Ourisias are most strongly developed in South America. The three largest and showiest New Zealand species are *O. macrocarpa* from the Fiord region of Otago, *O. calycina* from the South Island mountains north of the Sounds, and *O. macrophylla* from subalpine habitats ranging from Cape Colville south to North Otago. All have a stout rootstock with numerous radical leaves from which tall stout flower-stalks arise, each terminated by massive heads of large, white, whorled flowers.

O. macrocarpa has each leaf-blade rounded and cordate at the base which serves to distinguish it from the more northerly *O. calycina* (commonly regarded as a variety of the former plant) which has an ovate leaf, wedge-shaped at the base. The MOUNTAIN FOXGLOVE (*O. macrophylla*) is one of the main floral ornaments of the subalpine shrubberies of Mt. Egmont, but it occurs commonly on Tongariro and other northern mountains also.

J. S. Thomson, photo

FIG. 105. Mountain Primula (*Ourisia macrocarpa* var. *calycina*) in garden of the late J. Scott Thomson, Dunedin

At altitudes of 4,000 feet and over, a not uncommon plant in moist sheltered gulches between rocks, or on shady peaty soils on the rocks themselves, is a very distinct species called *O. sessilifolia* distinguished by the copious covering of glandular hairs on its dark-green, prostrate leaves. It grows in situations liable to be covered by the winter snows. On Mt. Anglem in Stewart Island a small colony still persists in a small funnel or couloir near the actual summit.

The CREEPING MOUNTAIN FOXGLOVE (*O. caespitosa*) differs in habit from any of the above in that it forms extensive mats with bright green, fleshy, glossy leaves on stony mountain fellfields which in December are hidden by sheets of lovely white flowers over half an inch in diameter, borne on short, erect pedicels. It is a common plant at high altitudes on the mountains of the two main islands, but in Stewart Island it is known only from the summit of Mt. Anglem. An Otago plant of similar habit but everywhere covered with glandular hairs is no less attractive, the flowers being rather larger and the leaves considerably so. Though this species (*O. glandulosa*) has recently been reported from the subalpine herb-fields of Nelson and Westland, it is much more common at high altitudes on the western mountains of Otago.

To the genus *Euphrasia* belong a numerous collection of dainty EYEBRIGHTS described by Cockayne as real alpine gems. Outside of New Zealand these plants live a semi-parasitic life on the roots of grasses and other plants, but it remains to be proved that such is also true of the indigenous species. The difficulty of successfully transplanting them into the garden, however, indicates that this partial parasitism probably occurs here too.

There is one species which has adopted a scrambling

or climbing habit among shrubs on the forest margin, though it also grows on rocks and claybanks where occasionally the stems are pendulous. Though this plant (*Euphrasia cuneata*) grows at sea level in Queen

J. S. Thomson, photo

FIG. 106. *Ourisia sessilifolia* (flowering), *Celmisia hectori*, and *Ranunculus buchanani* at 7,000 ft., Humboldt Mts., Otago

Charlotte Sound and at low levels on the nearby hills, in the North Island it is usually a high level plant. The branches are summer green and occasionally scramble to a height of five or six feet, bearing numerous flowers

—white streaked with purple on the outer side and yellow-throated within. There is a common North Island eyebright (*E. tricolor*), sometimes regarded as a non-climbing variety of the previous plant, which forms a conspicuous floral ornament of subalpine rocks and soils in the southern half of the island. Here the flowers are more closely spaced, so that the effect is much enhanced. The subterranean parts of both plants are perennial, the stems and leaves annual.

The common ALPINE EYEBRIGHT (*E. monroi*) has larger white flowers with yellow centres, but the fact is that almost all the eyebrights are alpine or subalpine. Two species have bright yellow flowers—*E. townsoni,* a small but quite conspicuous plant from northwest Nelson, and *E. cockayniana,* a similar plant with smaller bright yellow flowers from the mountains further south. Then there grows on coastal stations in Southland, Stewart Island, and nearby islets a diminutive but quite attractive little eyebright (*E. repens*) with short filiform creeping stems and comparatively large flowers, each produced singly in the axils of the minute upper three-lobed leaves.

New Zealand possesses two native calceolarias of which the larger (*Jovellana sinclairii*) is a North Island species of dripping rocks and wet shady banks mainly near East Cape. It is a bushy herb which thrives well as a garden or rockery plant in suitable places. *J. repens* is a smaller South Island plant of similar stations in Westland. It is rather more prostrate, smaller, and rather less floriferous, but has flowers similar to those of the NORTH ISLAND CALCEOLARIA—white, spotted with pink or purple as a rule, though the larger plant occasionally has the ground colour yellow in place of white.

W. Martin, photo

FIG. 107. *Thelymitra pauciflora*, a dainty ground orchid. Stewart Island

The Orchids

Amongst the twenty thousand known species of orchid are many of the finest flowering plants known. These are almost all of tropical origin and fabulous prices have sometimes been paid for some of the rarer sorts; but New Zealand, being practically at the southern limit of their distribution, cannot claim possession of any of these gorgeous tropical species. Nevertheless, though most of the seventy-one species are small and sometimes inconspicuous, others are quite attractive.

Germination of orchid seeds is only possible in the presence of certain minute fungi, and even the adult plants require their aid either to secure carbohydrates in the saprophytic species or water in many others. Pines, heaths, and *Gunneras* in like manner depend largely on fungi to do the work normally done by the root-hairs. The orchid known as *Gastrodia sesamoides,* common both to Australia and to New Zealand from Otira northwards, is stated to be, in the words of Edwin D. Hatch, our foremost student of these plants, 'unique in having a secondary association with nitrogen-fixing bacteria which swarm within the cells of the rhizome and stem'.

The six epiphytic orchids already referred to include three with attractive flowers, namely the New Zealand Dendrobe (*Dendrobium cunninghamii*) and the two species of *Earina. E. autumnalis,* known to the Maori as the Ruapeka, has the added attraction of a deliciously fragrant perfume. The remaining orchids numbering nearly sixty, are all tuberous, terrestrial plants of forest, swamp, manuka heath, open grassland, or road and river banks. Three dozen of these are identical with Australian orchids, and the suggestion has been made that their occurrence here is probably due to seeds which have been blown across the Tasman, for they are exceedingly small and light.

As might readily be surmised, the number of orchid species in any locality shows a progressive decrease from Auckland to Stewart Island. Thus Auckland species number well over fifty, Wellington orchids are listed as forty-eight and Dunedin has twenty-five. However, in one Wellington locality Druce estimates the tuberous ground orchids in manuka heath to number ten thousand to the acre, and my own observations indicate that dense concentrations also occur on some of the kauri swamp lands near Auckland.

Saprophytic orchids include a recently discovered SPIDER ORCHID (*Corybas cryptanthus*) and three species of *Gastrodia*. These last are tall, apparently leafless plants with very large, edible underground tubers, and tall unbranched stems which in the largest and commonest species (*G. cunninghamii*) the PEREI of the Maori, may on occasion be fully three feet tall. This *Gastrodia* is the most widespread of the three, ranging both to Stewart Island and Chatham Island, as well as to Australia and Tasmania. The stem ends in a long raceme of pendulous flowers, greyish-white in this species but brownish in the other two. It occurs both in the lowland rain-forests and in the subalpine beech forests.

The three genera with the biggest number of species are the helmet orchids (*Pterostylis*), the spider orchids (*Corybas*), and the bonnet orchids (*Thelymitra*) commonly referred to as the BLUE SWAMP ORCHIDS, though they are not less common in manuka heath.

Six of the twelve helmet orchids are confined to the North Island or to the Chatham Islands as well. All have the same characteristic type of flower somewhat resembling a fireman's helmet, though varying much in size and in detail. Much the largest and commonest is the tutukiwi (*P. banksii*), a plant normally six to

eight inches tall with numerous grassy cauline leaves about six inches long and half an inch wide, and terminated by a tall hooded, greenish, purple-striped flower up to three inches long with two erect filiform tails on the lateral sepals. The other species also have usually a single terminal flower, but two small members regularly have several flowers on each stem. These are *P. mutica* and the similar but larger *P. cycnocephala*,

W. Martin, photo

FIG. 108. New Zealand Begonia or Paritaniwha (*Elatostema rugosum*) on Waitakere Hills, Auckland

both probably of Australian origin. A very slender North Island species with minute leaves is that known as *P. trullifolia*. In common with the spider orchids, these plants usually grow in colonies, which apparently originate not from seed but from small bulbils produced by the initial plant.

The spider orchids which include the three SILVER-

BACKS (*Corybas macranthus, C. oblongus,* and *C. trilobus*) derive their popular name from the dull reddish flowers with long spidery tails on their floral parts. These gregarious orchids form colonies in moist shady stations both within and outside the forest or shrubbery and very commonly on roadside or riverbanks. It has been stated that only the earliest plants produce flowers and these are said to be smaller than the later plants; but it is obvious that very few plants ripen fertile seeds. The silverbacks each have a single, round, fleshy, brittle leaf one or two inches wide and cordate at the base, which is thin and membraneous when dried. The flowers are produced singly and are reddish-purple, being large for the size of the plant. *C. rivularis* has a thinner, triangular, pointed leaf and a flower-stalk that lengthens greatly as the seeds ripen. The sepals bear long filiform tips.

The name *Thelymitra* means a women's bonnet. These bonnet Orchids are mostly swamp plants or occupants of manuka heath, and most are at once distinguished by their deep blue, purple, or mauve flowers. They grow also on roadsides and in moist grassland as in the case of *T. longifolia* (the commonest species), *T. venosa*, and *T. caesia*. The flowers of the MAIKUKU (*T. longifolia*) vary much in colour from green to white, pink, or pale blue. The other species, however, are always some shade of blue, and frequently such species as *T. caesia* with flowers over an inch across are most attractive. This is the tallest species, odd plants often attaining a height of nearly three feet.

A rather uncommon swamp orchid in New Zealand but one more common overseas (*Spiranthes sinensis*) can be recognised at once by the spiral arrangement of the dull reddish flowers. The writer once gathered it also near Te One in Chatham Island.

Few of the other bulbous ground orchids have any claim to beauty though the pink flowers of *Caladenia carnea* and the larger white or pink flowers of *Aporostylis bifolia* are dainty and ornamental. Most have greenish flowers, or greenish flowers striped with purple. Those who desire to make a fuller acquaintance with the New Zealand orchids cannot do better than consult the recent papers by Capt. E. D. Hatch in volumes 76 to 80 of the *Transactions* of the Royal Society of New Zealand, where they will find excellent illustrations and descriptions of all known species.

APPENDIX

The following are selected books and papers giving popular information about New Zealand plants.

Flowering Plants

Manual of the New Zealand Flora. T. F. Cheeseman.
The Forest Flora. T. Kirk.
Student's Flora of New Zealand. T. Kirk.
The Vegetation of New Zealand. L. Cockayne.
New Zealand Plants and their Story. L. Cockayne.
Cultivation of New Zealand Plants. L. Cockayne.
New Zealand Trees. L. Cockayne and E. Phillips Turner.
New Zealand Trees and Shrubs. H. H. Allan.
New Zealand Trees. J. W. Matthews.
The Story of the Kauri in Word and Picture. A. H. Reed.
New Zealand Native Plant Studies. Wm. C. Davies.
The Botany of Auckland. A. Wall and L. M. Cranwell.
The Botany of Christchurch. A. Wall.
The Botany of Mt. Cook. A. Wall.
The Vegetation of Marlborough. W. Martin.
New Zealand Alpines. W. B. Brockie.
Orchid Hunting in Otago. H. K. Dalrymple.
Plant Life in Maoriland. M. W. Crookes.

Ferns and Lycopods

Handbook of New Zealand Flora. T. F. Cheeseman.
New Zealand Ferns. H. B. Dobbie.
Ferns of New Zealand. H. C. Field.
A Book of Ferns. Greta Stevenson.

Revised List of New Zealand Filicinae. M. W. Crookes in *Trans. Roy. Soc. N.Z.* Vol. 77.

Key to New Zealand Lycopods. J. W. Dawson in *Tuatara* Vol. 5, No. 1.

MOSSES AND LIVERWORTS

Handbook of the New Zealand Flora. J. D. Hooker.

Handbook of the New Zealand Mosses. G. O. K. Sainsbury.

Studies in the Bryology of New Zealand. H. N. Dixon. Bulletin No. 3 N.Z. Institute.

Reviews of various Hepatic Genera. E. Amy Hodgson in *Trans. Roy. Soc. N.Z.* Vols. 73 to 80.

FUNGI

Some Notes on Agarics. Greta B. Cone. *Bull. Well. Bot. Soc.* No. 20.

Gasteromycetes of Australia and New Zealand. G. H. Cunningham.

Fungus Hunting in Otago. H. K. Dalrymple.

ALGAE

Various papers. R. M. Laing in *Trans. N.Z. Inst.* Vols. 18 to 69.

Various papers. Trans. Roy. Soc. N.Z. Recent volumes.

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Biographical Note

For fifty years the study of the native plants of New Zealand has been Mr Martin's main interest and work. He has given distinguished service to education in his own country, and in the world abroad has achieved recognition as an authority in his subject.

Since his retirement in 1945 Mr Martin has made a special study of Stewart Island flora, recording no fewer than 400 flowerless plants not previously known to exist there. His private collection of dried New Zealand mosses and lichens is the largest in the world, and he recently presented to the Botany Division of DSIR 7000 specimens of native mosses and to the Dominion Museum, Wellington, a collection of our native flowering plants.

On the eve of the publication of the fourth edition of *Flora of New Zealand* Mr Martin was presented by the Royal New Zealand Horticultural Society with the Loder Cup in recognition of his outstanding work in this field. The Loder Cup was donated over 50 years ago by Gerald Loder 'to encourage the protection and cultivation of the incomparable flora of the Dominion'.

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